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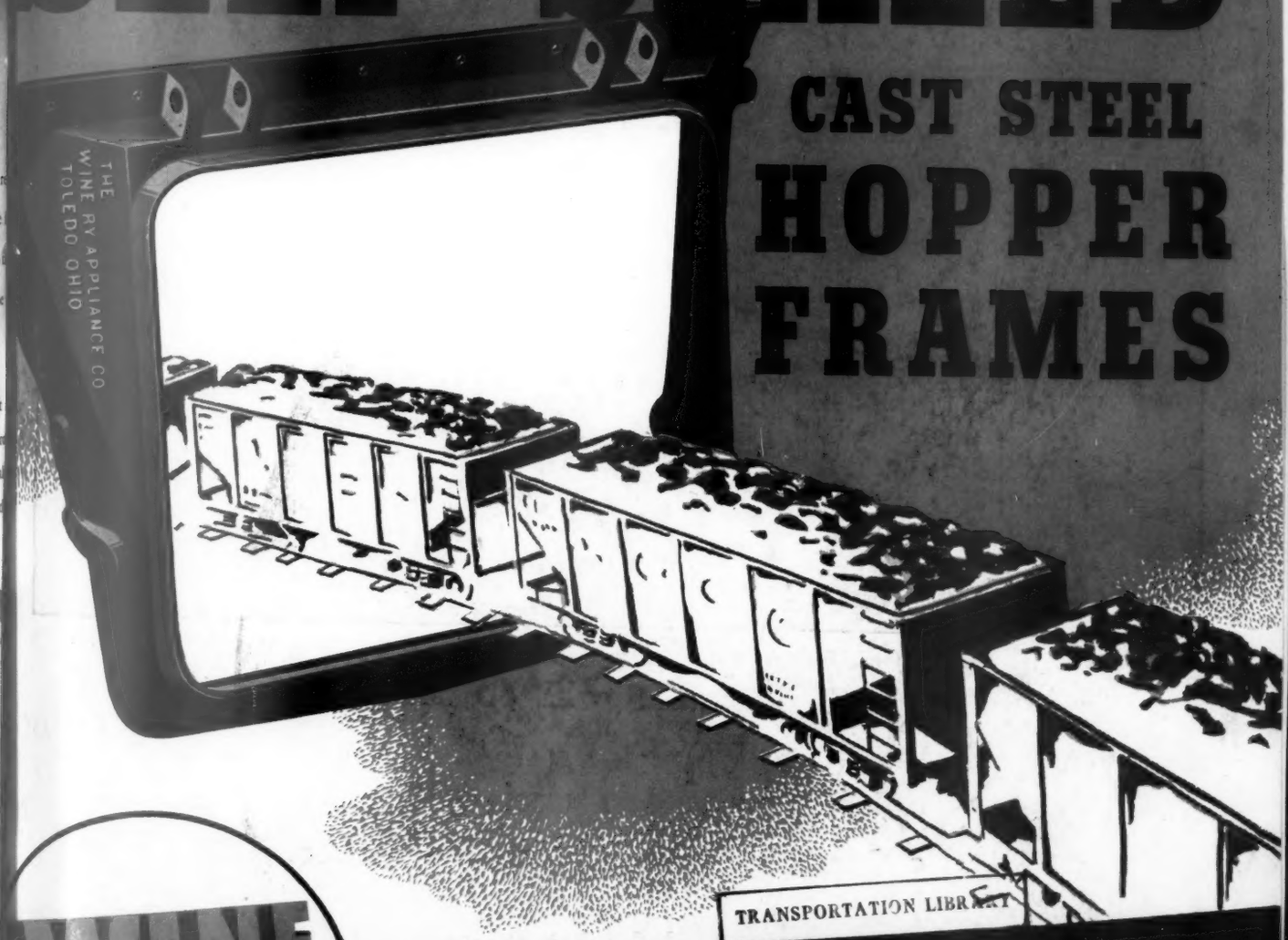

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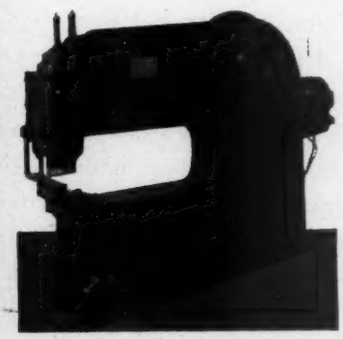

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THE EDITOR'S DESK

MATERIAL AND EQUIPMENT SITUATION

The railroads have had and are having a difficult time in securing materials and equipment vital to their successful operation. Fortunately they have had the wholehearted support and co-operation of ODT and the railway supply manufacturers. They have had to struggle along, however, as best they could with limited supplies, and that at a time when the manpower problem has been growing steadily worse.

In the last analysis, in spite of all these handicaps, they have made good to a remarkable extent in handling the traffic offered to them, and without congestion. It has not been an easy or a simple task. It has required careful planning and a lot of ingenuity.

While there is no question but what they are suffering from deferred maintenance of one sort or another, mileage has been built back into the cars and locomotives and they are giving an excellent account of themselves, even though much of the equipment is not of the most modern design and cannot be operated as efficiently as that which is new and up-to-date. It must be admitted that, generally speaking, the government agencies, in the light of other pressing demands, have been reasonably successful in protecting the railroads with those materials and supplies necessary to keep the machine going.

What the year may bring forth is not at all clear. Apparently the production of war equipment and materials has thus far progressed even beyond the expectations of the Administration. It takes time to rearrange our whole economy and set up the machinery to get ample materials to fighting fronts all over the world. Results seem to indicate that these needs are not only being met, but, what is much more important, reasonable reserves are gradually being built up at places where they may be most needed. This is, of course, as it should be, and well back of the lines as we are, we can well afford to scrape along on a minimum of materials and supplies, always assuming that we must guarantee ample transportation, which is fundamental to the continued success of our production processes and in getting supplies to the fighting fronts. In the light of these facts, it may well be that more consideration can be given to the needs of the railroads as the year goes on.

One thing is certain. The railroads have surpassed all expectations in doing their part of the job, and those who predicted—and in some cases it is to be feared, hoped for—a breakdown of the railroads and government operation have been disappointed. Let's do our level best with the limited equipment, supplies and manpower, to keep them disappointed. We will thus make a large contribution to the continuance and preservation of the American way of life.

Roy V. Wright

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Name Registered, U. S. Patent Office.

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FEBRUARY, 1943

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Published on the second day of each month by

Simmons-Boardman Publishing Corporation

1309 Noble street, Philadelphia, Pa. Editorial and Executive Offices: 30 Church street, New York, and 105 West Adams street, Chicago. Branch offices: Terminal Tower, Cleveland; 1081 National Press bldg., Washington, D. C.; 1038 Henry bldg., Seattle, Wash.; 300 Montgomery street, Room 805-806, San Francisco, Calif.; 530 W. Sixth street, Los Angeles, Calif.

Subscriptions, payable in advance and postage free, United States, U. S. possessions and Canada: 1 year, $3; 2 years, $5. Foreign countries: 1 year, $4; 2 years, $7. Single copies, 35 cents. Address H. E. McCandless, circulation manager, 30 Church street, New York.

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The Railway Mechanical Engineer is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.), and is indexed by the Industrial Arts Index and also by the Engineering Index Service. PRINTED IN U. S. A.

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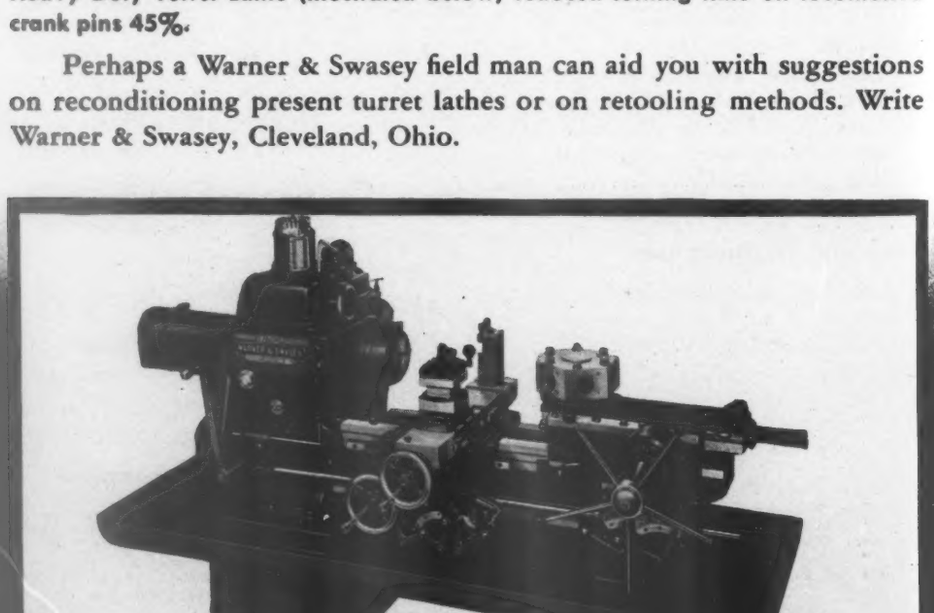

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Gas-Turbine Locomotive*

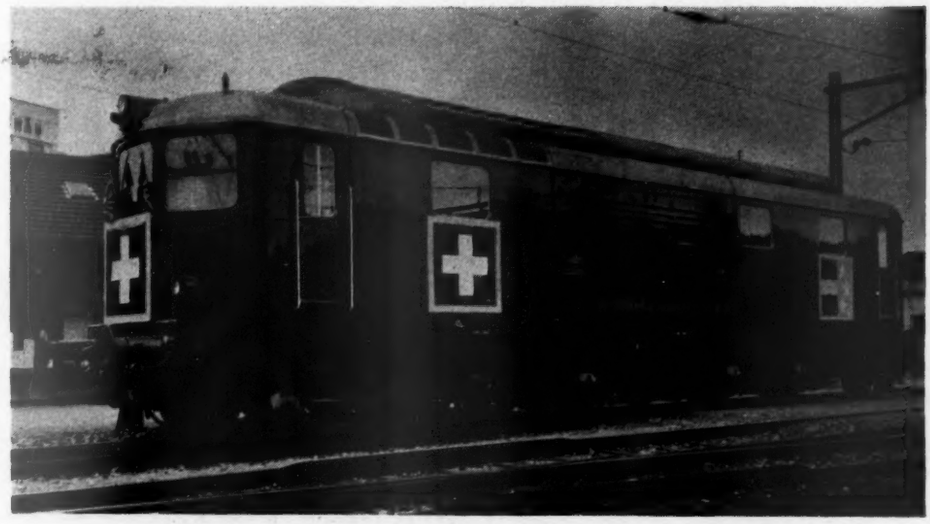


Fig. 1—Swiss Federal Railways gas-turbine locomotive

By Paul R. Sidler†

In 1939 Brown, Boveri & Company, Ltd., undertook to build the first gas-turbine locomotive for the Swiss Federal Railways. While the outbreak of the war delayed its completion the locomotive was completed in the fall of 1941.

Again, due to the war conditions in all countries surrounding Switzerland, there is a severe shortage of any liquid fuel, so that it was not possible to arrange for as large a number of test runs over a wide variety of lines as would otherwise have been desirable. However, several road tests of sufficient duration and over various tracks were made to demonstrate that not only the guarantee conditions had been met but the expectations were exceeded in many instances.

The completed locomotive is shown in Fig. 1 as it started out on the first trip under its own power in September, 1941.

The complete power unit is assembled on a heavy auxiliary frame and can be lifted into the locomotive as a whole, as shown in Fig. 2.

Before going into these test results, it might be well to recall briefly the basic layout of a gas-turbine power plant, the principal elements of which are shown in Fig. 3.

The compressed and preheated air is introduced into the combustion chamber partly as combustion air through the nozzle ring *1* and partly as cooling air through slots *2*. The fuel enters through the injection nozzle *3*. Combustion gas and cooling air mix in chamber *4* and form the driving gas proper, which expands through the gas turbine. The exhaust gases which still have a high temperature, pass the air preheater from *5* to *6* where they leave through the locomotive roof. The air inlet to the compressor is at *7*. The outlet air duct *8* from the compressor to the heat exchanger is provided with several expansion joints *9* to allow for different expansion in the gas turbine set and the preheater.

Table 1—Characteristics of the Swiss Combustion Turbine Locomotive

Continuous output of power unit at generator coupling (at a turbine speed of 5,200 r.p.m. and a generator speed of 812 r.p.m.), hp.:	2,200
Tractive force rating at the wheel tread:	
At starting (from 0-16 m.p.h.), lb.	29,000
1 hour (at 30 m.p.h.), lb.	17,000
Continuous (at 45 m.p.h.), lb.	11,000
Maximum speed, m.p.h.	70
Maximum service weight including fuel, lb.	202,000
Maximum axle load, lb.	35,200

Built into the same frame with the main generator *F* is an auxiliary generator for electric train heating, rated at 200 kw.

It seems desirable to point out that electric transmis-

* Abstract of a paper presented at the A. S. M. E. annual meeting in a joint session of the Oil-Gas Power and Railroad Divisions, Dec. 2, 1942.

† Resident engineer, Brown, Boveri & Co., Ltd., New York.

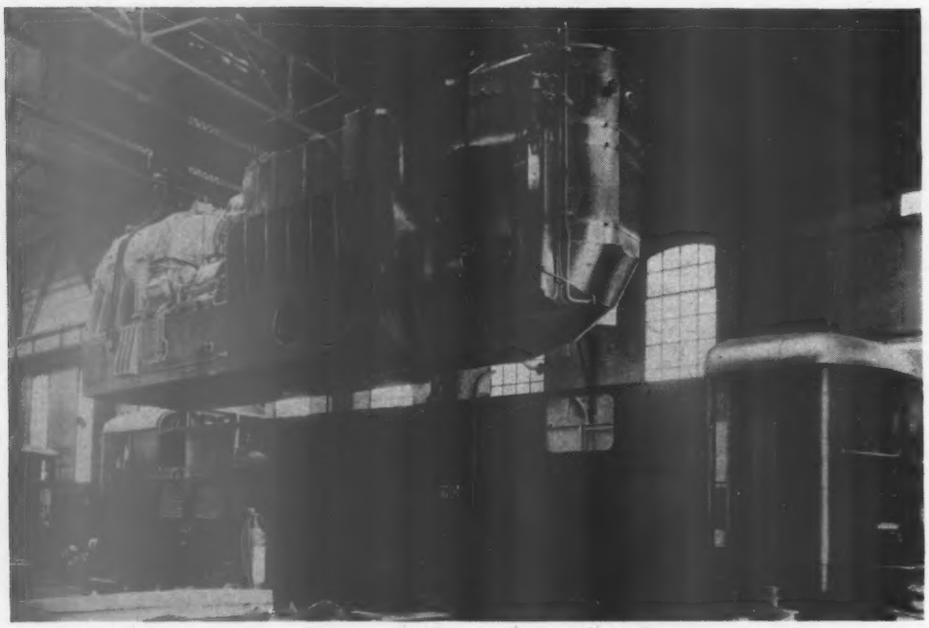


Fig. 2—Gas-turbine unit being lowered into the locomotive in the shop

sion was selected because its operation is well known and tried out while hydraulic or mechanical transmissions for such outputs do not appear to have outgrown an experimental stage and would, therefore, introduce considerable uncertainties. The fact that this locomotive with electrical transmission has been in operation for more than one year, while projects with hydraulic transmission, developed elsewhere, have not progressed beyond the paper stage, certainly confirms the correctness of this choice.

The governing system of the gas-turbine locomotive was adapted with a few changes from the well-tried pressure oil-operated field regulating system that has been in satisfactory operation on many Diesel-electric locomotives.

Table II—Comparative Data for Three Test Runs

	Run No. 1	Run No. 2	Run No. 3
Length of the line, miles	100.2	60.4	41.55
Total weight of train, short tons	430	313	313
Change of elevation, ft.	+906	+1358	−266
Average ruling grade, per cent	0.171	0.4265	−0.121
Running time including stops, min.	147.5	101.5	52
Number of stops	9	7	1
Running time without stops, min.	130.5	83.5	50
Average speed without stops, m.p.h.	46	43.5	49.7
Output at generator terminals, kw.-hr.	1,597.6	818.5	428.3
Input at generator coupling, kw.-hr.	1,735.5	892.5	466
Fuel consumption (Bunker C), lb.	2,805	1,783	998
Fuel consumption, lb. per hr.	1.2063	1.4923	1.5973

The diagram, Fig. 4, shows the operating stands at both ends with the main controllers. By moving this controller from step to step the engineman regulates the supply of fuel to the burner and the speed of the gas-turbine set and, through the speed governor, also controls the generator field regulator which in turn influences the electrical output. The proper co-ordination of all these devices is assured by oil relays operated from a common pressure oil supply which, during starting, also lubricates all bearings.

The operating characteristics of the gas turbine power unit have been plotted in Fig. 5 from measurements taken during acceptance tests. The principal characteristics of the locomotive as prescribed in the order are shown in Table I.

The weight requirements were imposed by the contemplated service of the locomotive on branch lines where traffic density has not justified electrification. For main-line service the axle load could be about 15 per cent higher.

Results of Service Tests

Table II shows the results of actual test runs over three territories differing in physical characteristics. Table III gives the results of acceleration tests with a 321-ton train (including the locomotive). Data derived as a result of these test runs has already shown the possibility of improvements that could be made on future locomotives of this type, particularly with reference to fuel consumption at partial loads.

Comparisons With Steam and Diesel Power

In a paper before the A. S. M. E. last year E. E. Chapman, Atchison, Topeka & Santa Fe, gave an interesting comparison of steam and Diesel-electric locomotives.* Although the gas turbine locomotive has not yet accumulated sufficient operating experience to establish all characteristics accurately it is of interest to tabulate some of Mr. Chapman's findings and add the corresponding data for the gas turbine locomotive. This has been done in Table IV. Some figures for the latter are, it is admitted, based on careful estimates rather than operating experience over extended periods of time.

Table III—Acceleration Tests With 321-Ton Train

Grade, per cent	Speed m.p.h.	Time measured, sec.	Time guaranteed, sec.	Acceleration, m.p.h. per sec.
0	56.00	112	150	0.5000
1.2	37.30	97	150	0.3850
1.8	24.85	90	100	0.2760
2.6	18.65	100	100	0.1865

Some further comments in connection with several of the above characteristics seem appropriate:

The cost of the gas-turbine locomotive is based on quantity production similar to Diesel or steam locomotives.

* An abstract of Mr. Chapman's paper appeared in the Railway Age for July 26, 1941, page 149.

As the gas-turbine locomotive has no reciprocating parts, the time out for repairs should be the smallest of the three. One may, of course, question the durability of the turbine blading. For the conservative gas temperatures chosen, experience with a large number of exhaust-gas turbines and continuous combustion turbines shows practically no wear of this blading even after several years of operation.

The gas-turbine locomotive requires no water, but does need a considerably larger fuel tank than the Diesel locomotives, thus taking a longer time for refuelling.

As the gas-turbine locomotive has no reciprocating parts and works below critical speeds throughout the range, it should allow of even higher schedule speeds than the Diesel locomotive.

Neither the Diesel nor the gas-turbine locomotive have unbalanced weights; the gas-turbine locomotive has a lower weight per horsepower, thus less track wear.

The equality of fuel costs for Diesel and gas-turbine locomotive is valid only for oil-producing countries or other regions where the cost of fuel oil is about half that of Diesel oil.

The lubricating-oil costs for the gas-turbine power plant are negligible; the axles and the running gear require, of course, the same amount of lubrication as in other types.

The small water requirements for the auxiliary Diesel engine for starting the gas turbine has not been considered, as this set will only run a few minutes each day; the use of air-cooled auxiliary Diesel engines is contemplated in future locomotives.

While it is clear from this comparison that the gas-turbine locomotive is not as yet a serious competitor for the Diesel locomotive, it is also evident that in certain classes of service it will show marked advantages. It should be particularly suitable for express service over long distances in areas where water is scarce and where there is a considerable difference in the cost of Diesel oil as against ordinary fuel oil.

Table IV—Comparative Characteristics of Three Types of Motive Power

	Steam	Diesel	Gas turbine
Approximate cost per hp.	$35	$87	$65
Efficiency at draw-bar, per cent	6-8	26-28	15-16
Mileage per year	180,000	250,000	over 250,000
Time for tanking and refuelling	greatest	least	small
High scheduled speed	lowest	higher	higher
Track wear	large	less	least
Power braking	none	full power	full power
Approximate life in years	30	15-20	30
Maintenance	lower	high	least
Fuel costs, per cent	100	50-75	50-75
Lubrication costs			
Per cent of fuel costs	10	20-30	less than 5
Water costs			
Per cent of fuel costs	10	small	nil
Starting effort	minimum	larger	larger

Discussion

R. Herold (Sulzer Bros.): Up to now, the steam locomotive has endeavored to defend its position against the inroads of the Diesel. Now, it is the Diesel locomotive's turn to be on the defensive. Whether the gas turbine locomotive will become a serious competitor for the Diesel locomotive depends on various factors.

The most important of these factors is availability. The high availability of the Diesel-electric locomotives makes it possible for a certain number of such units to replace a larger number of steam locomotives. The gas-turbine locomotive will have a high availability, due to the simplicity and serviceability of its components. As the gas-turbine locomotive will hardly ever be advantageous in switching service, let us consider only main-line operation. Reports indicate that in this kind of service, the average availability of American Diesel-electric locomotives is better than 90 per cent; in some instances it is 98 or even 100 per cent. Under such circumstances, the gas-turbine locomotive will not be afforded a chance to out-distance the Diesels. It may do just as well, but it can do no better. It appears therefore that availability is not a factor in competition.

With regard to first cost, the gas-turbine locomotive has the advantage. Mr. Sidler has quoted a price of $87 per hp. for the Diesel-electric locomotive. But Mr. Sidler's figure of $65 per hp. for the gas-turbine locomotive is an assumption. The price difference between the two types may not be as high as $22.00. Moreover, the price of Diesel-electric locomotives can be reduced by redesign. At the present time, the competing American designs follow the same general patterns; this may not necessarily remain so.

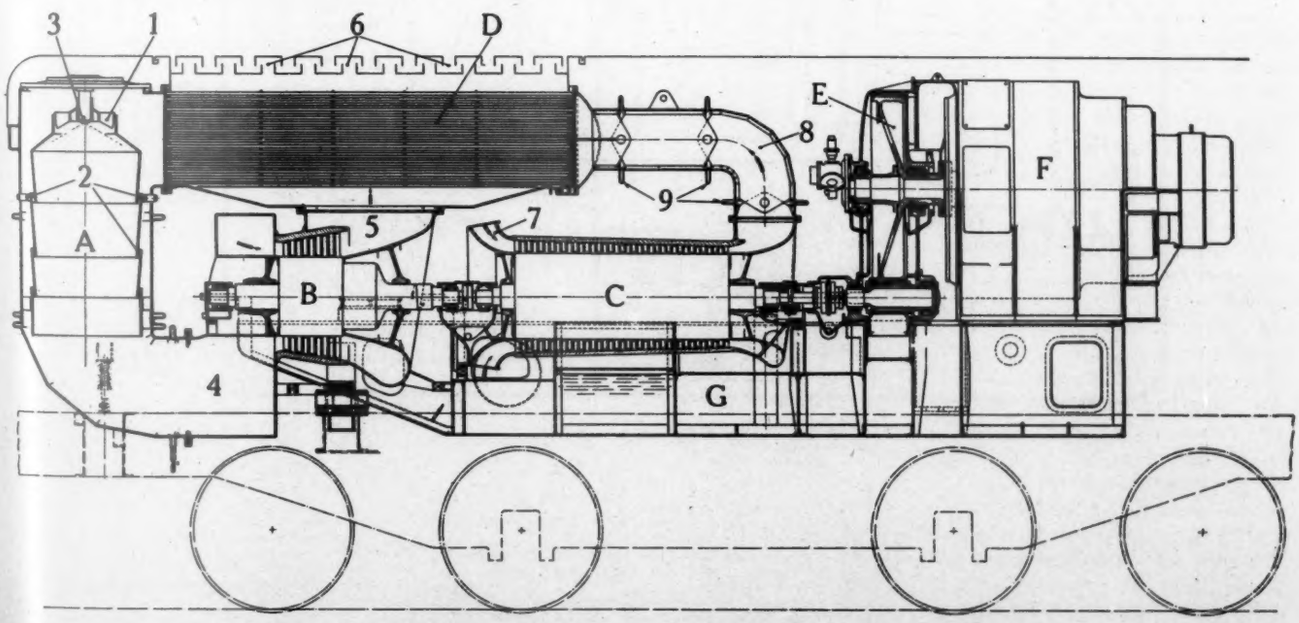


Fig. 3—Arrangement of the several elements of the power unit in the locomotive

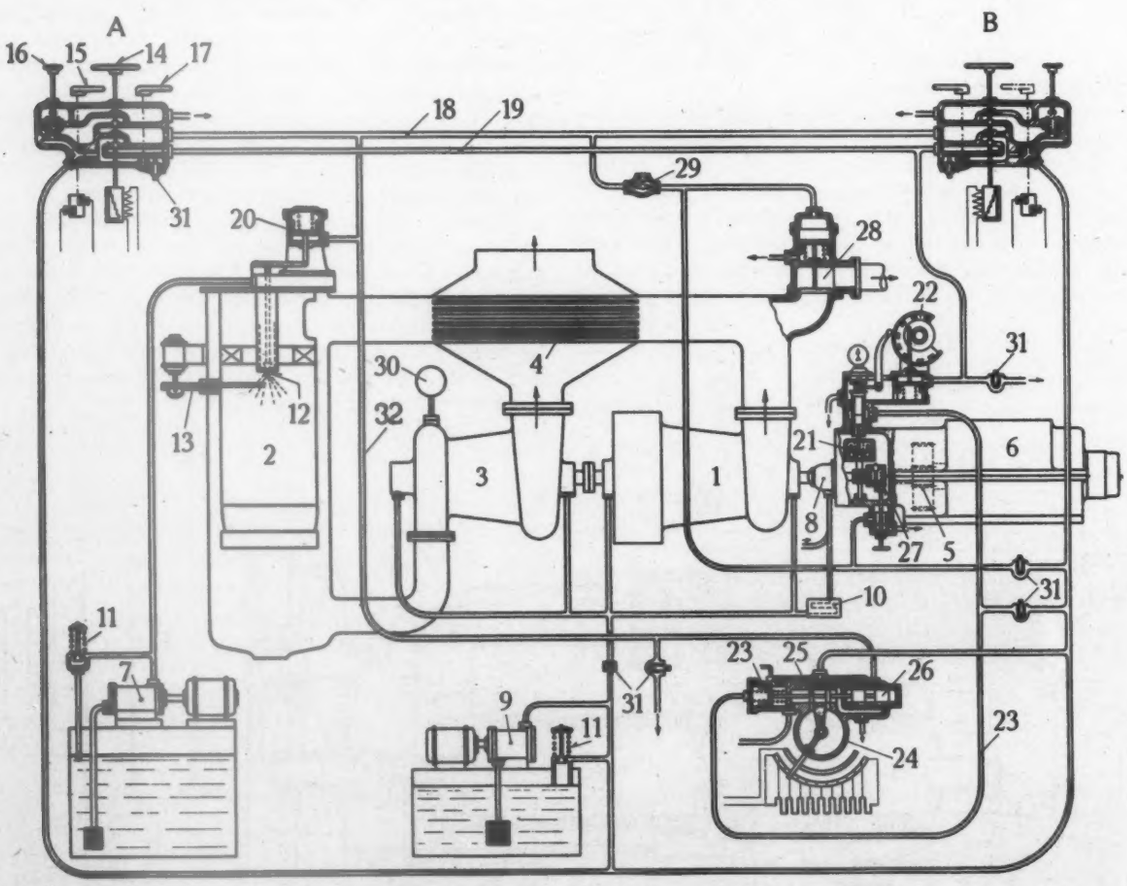
The higher first cost of the Diesel-electric locomotive is compensated by its lower fuel consumption or, in other words, by its better thermal efficiency. Under test conditions, a Buchi supercharged 4-cycle locomotive Diesel engine has a thermal efficiency of 38 per cent, or even better. Through the use of suitable control arrangements, this figure can be maintained from full load to one quarter load. The gas-turbine has, under test conditions and at its best point, a thermal efficiency of 17 per cent maximum. At part load, this efficiency drops rapidly, at one quarter load it is only 10 per cent. Therefore, the gas-turbine uses, at its best point, more than twice as much fuel as the Diesel. Even if the gas-turbine should be able to burn lower grade fuels than the Diesel—which is open to question—it could hardly run as economically as the Diesel. The efficiency of the gas-turbine can of course be increased by various recuperators, but these devices would increase the first cost of the locomotive, and the gain in operating economy would be compensated by higher amortization costs.

Lubricating oil consumption is a point which is all in favor of the gas turbine, even if Mr. Sidler's figure of 5 per cent of fuel cost is misleading because fuel consumption of the gas-turbine is more than twice that of the Diesel. Lubricating oil consumption figures for some types of Diesel-electrics are surprisingly high.

A point against the gas-turbine locomotive is its sensitiveness to the temperature of the ambient air, or intake air. It is, of course, the compressor which is responsible for this situation. The horsepower absorbed by the compressor and developed by the turbine are a multiple of the net power obtainable at the coupling. This entails that a slight drop in the efficiency of the compressor will noticeably reduce the net power and the over-all efficiency. If the power of the gas-turbine locomotive is taken as 100 per cent at 68 deg. F., it drops to 77½ per cent at 100 deg. F., whereas for the Diesel the difference is only 5 per cent. As, in this country, a locomotive must unavoidably operate under climatic conditions which vary a great deal, it follows that the design must be based on the most adverse conditions that may be encountered, and from this it follows that the gas-turbine locomotive must be over-dimensioned 20 per cent for normal conditions.

Summing up, the gas turbine locomotive in its present stage of development appears to have the following main advantages in comparison with the Diesel electric locomotive; lower first cost, greater simplicity, lower lubricating oil consumption. The disadvantages are: high fuel consumption, unfavorable operation at part load, dependence on temperature.

The coming years will no doubt bring many heated



A-B—Engineman's cab
1—Compressor
2—Combustion chamber
3—Gas turbine
4—Air preheater
5—Gear set
6—Generator
7—Fuel oil pump
8—Control and lubricating oil pump
9—Auxiliary pump
10—Oil cooler
11—Pressure limiting device
12—Fuel-oil nozzle
13—Ignition rod with remote control
14—Main control wheel with double valve and excitation resistor
15—Reversing switch with oil cut-off device and removable handle
16—Temperature regulator
17—No-load speed adjustment
18—Control-oil system for the fuel oil
19—Control-oil system for the speed regulation
20—Operating piston for the fuel-oil nozzle
21—Speed regulator
22—Camshaft for the adjustment of the speed from the engineman's cab (operates the sleeve of the regulator *21*)
23—Field regulator hydraulic control line from *17*
24—Field regulator with rotating piston
25—Control piston for *24*
26—Piston controlling fuel-oil quantity during regulation
27—Safety speed regulator
28—Safety valve
29—Back-pressure valve
30—Safety temperature regulator
31—Oil trap

Fig. 4—Gas-turbine generating plant

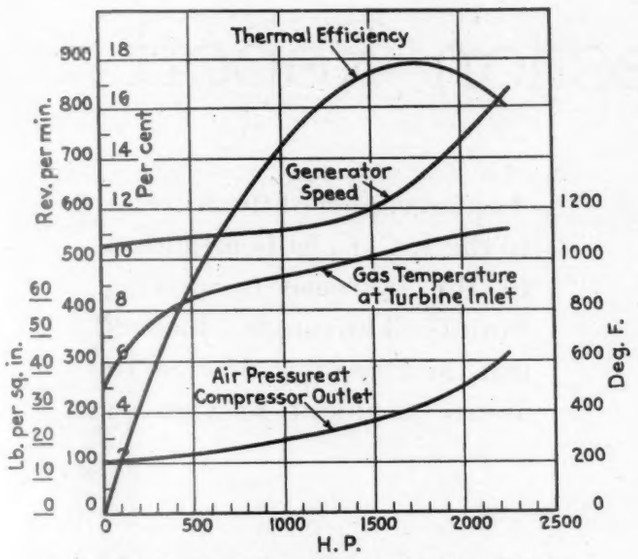


Fig. 5—Chart showing conditions relating to efficiency

arguments between the proponents of gas-turbine locomotive and Diesel locomotive. It is not impossible that, some day in a rather distant future, the two types will be merged into one. Now, already, the builders of the gas-turbine locomotive have made a small concession to Diesel manufacturers by installing a Diesel as a starting engine. On the other hand, many engines in Diesel locomotives have a small gas turbine, driven by exhaust gases. The relative importance of the two plants may become equal. The gas turbine plant wastes a great deal of energy in cooling the hot combustion gases to a temperature acceptable for the turbine blades. If the combustion were transferred into a compression-ignition engine, the loss in thermal energy would be much smaller. In a recent paper, Mr. F. Oederlin of Sulzer Bros. has referred to an interesting case in the development of the supercharged two-cycle engine; when supercharged to 85 lb. per sq. in. the engine develops just enough power to drive the supercharging compressor and it does not deliver any power at the coupling. Such an engine is nothing but an efficient producer of hot gases; the high temperature part of the combustion and expansion process takes place in the Diesel and is used to drive the compressor, while the lower part takes place in the gas turbine. The Diesel with compressor corresponds to the boiler of a steam plant. A certain number of such "boilers" could feed a single turbine driving a single generator. Such a multi-engine locomotive plant would correspond to the solution which P. B. Jackson of the Aluminum Company of America has suggested. But, as emphasized before, this solution is by no means just around the corner and it will require a great deal more research work.

J. T. Rettaliata (Allis-Chalmers): The operating data, presented by Mr. Sidler, are fairly complete but I would appreciate being informed of the amount of surface used in the heat exchanger as well as the pressure drops on the air and gas sides, and the overall heat transfer coefficient obtainable.

In this country Allis-Chalmers has conducted an engineering study[1] of the gas turbine as a drive for locomotives of larger output than that discussed by the author. Various arrangements have been considered including electrical and hydro-mechanical transmissions, with the latter type appearing to have certain weight and efficiency advantages. The study indicates that a 5,000 hp. gas-turbine locomotive with hydro-mechanical transmission would have a total operating specific weight of 112 lb. per hp. at the axle and would be capable of speeds up to 120 m.p.h.

Mr. Sidler gives a maximum service weight of 101 tons or 202,000 lb. for the Brown, Boveri gas-turbine locomotive. With an assumed efficiency of 85 per cent for the electrical elements of the transmission the total service specific weight for this locomotive is 108 lb. per hp. at the axle. Even though the locomotive used in the Allis-Chalmers study is designed for a maximum speed of 120 m.p.h. it can be seen that its specific weight is close to that of the Brown, Boveri locomotive which has a maximum speed of 70 m.p.h.

In the interest of weight reduction and also to achieve more uniform distribution of weight, the power plant of the locomotive studied by Allis-Chalmers has been divided into two units of 2,500 hp. each. In each unit a two-turbine design has been adopted—one turbine furnishes sufficient power to drive the compressor only, and the excess gas generated operates the other turbine, thereby providing propulsive power to the locomotive. The use of separate turbines improves the partial load performance since the compressor and its driving turbine can operate independently at their optimum speed regardless of the speed of the locomotive.

The hydro-mechanical transmission, consisting of a torque converter and hydraulic coupling for low and high speeds, respectively, affords a high tractive force at starting without a sacrifice in maximum speed. Control of the locomotive speed is accomplished by a combination of manual and governor regulation of the fuel burned in the combustion chamber and also by throttling the gas supplied to the power turbine.

The transmission for each turbine consists of two sets of torque converters and hydraulic couplings so that each driving axle of a truck has its connected set. Thus the individual hydraulic units, which operate at 1,535 r.p.m. when the locomotive speed is 90 m.p.h., are about three feet in diameter and transmit about 1,200 hp. each. Accordingly, they do not exceed either in size or speed similar units which have been built previously.

The tractive force of the locomotive, at the drawbar, at starting is 78,000 lb. while at 100 m.p.h. it is 11,000 lb.

Mr. Sidler: I have no accurate information on the surface of the heat exchanger. I can, however, mention the temperature conditions in this air preheater in the hope that this will at least partly answer the question. At full load of the gas turbine the air temperature is increased from 201 to 284 deg. C., while the temperature of the gas through the preheater decreases from 366 to 279 deg. C.

From the figures shown in Table II it can be established that the average efficiency of the electric generator for the varying load during the run is between 91.5 and 92 per cent. This machine is built according to the latest practice for railroad equipment and certainly has a full load efficiency around 95 or 96 per cent.

With reference to Mr. Herold's questions on efficiency, fuel costs and influence of air temperature, the following comments are made:

The sloping efficiency curve of the gas turbine at partial loads is, of course, an inherent characteristic of turbo-type machinery. I have already indicated in the paper that data have been developed for improving this situation. Such an improvement will consist in operating the gas turbine at higher inlet gas temperature at partial loads. In this manner the efficiency at these points can also be improved and a flatter curve obtained.

(*Continued on page 79*)

[1] "An Engineering Study of the Combustion Turbine Locomotive," by J. L. Ray, Allis-Chalmers Bulletin No. B-6066, Sept. 6, 1939.

Locomotive Inspection Report

Annual report of the Bureau to the I. C. C. calls attention to the increase in defects found—Thorough inspection and repairs needed to assure accident prevention

IN the annual report of the Bureau of Locomotive Inspection submitted by Director John M. Hall to the Interstate Commerce Commission for the year ending June 30, 1942, there are many indications of the pressure under which the railroads are operating at the present time. Particularly with reference to steam locomotives there has been a noticeable increase in defects, as well as in accidents and casualties. While reports were filed for 285 fewer locomotives in 1942 than in the previous year the activities of the Bureau's inspectors were reflected by the fact that 7,776 more inspections were made and 1,400 more locomotives were found defective, an increase of one per cent over 1941. While 7,237 defects were found on the locomotives inspected only 474 steam locomotives were ordered out of service as compared with 560 the previous year.

In the case of locomotives other than steam the number of units for which reports were filed increased, as did the number of inspections and defects found. The character of the defects, however, was such as to require fewer units ordered out of service.

In the matter of accidents and casualties the record for 1942 is not a favorable one for there was a decided increase, as shown by the accompanying tables.

Table I—Reports and Inspections—Steam Locomotives

	Year ended June 30					
	1942	1941	1940	1939	1938	1937
Number of locomotive for which reports were filed	42,951	43,236	44,274	45,965	47,397	48,025
Number inspected	113,451	105,675	102,164	105,606	105,186	100,033
Number found defective	10,970	9,570	8,565	9,099	11,050	12,402
Percentage inspected found defective	10	9	8	9	11	12
Number ordered out of service	474	560	487	468	679	934
Number of defects found	44,928	37,691	32,677	33,490	42,214	49,746

Explosions and Other Boiler Accidents

All of the 13 explosions that occurred in the fiscal year, in which 23 persons were killed and 18 injured, were caused by overheating of the crown sheets due to low water. There was an increase of two accidents, an increase of 12 persons killed, and a decrease of 11 persons injured from this cause as compared with the preceding year.

In three of these accidents, in which nine employees were killed and two employees and two passengers injured, the force of the explosions tore the boilers from the running gear and hurled the boilers and other parts for considerable distances from the points of the explosions. In another instance where the boiler was torn from the running gear and two employees were killed and one was injured, the accident occurred in a tunnel, the boiler struck the roof of the tunnel, and alighted on the front engine of the articulated running gear. In three other accidents, in which five employees were killed and four injured, the boilers remained attached

Table III—Reports and Inspections—Locomotives Other Than Steam

	Year ended June 30					
	1942	1941	1940	1939	1938	1937
Number of locomotive units for which reports were filed	3,957	3,389	2,987	2,716	2,555	2,416
Number inspected	6,728	5,558	4,974	4,581	4,024	3,615
Number found defective	358	319	298	260	274	328
Percentage inspected found defective	5	6	6	6	7	9
Number ordered out of service	12	21	16	14	9	24
Total number of defects found	928	905	766	696	769	991

Table II—Number of Casualties Classified According to Occupation—Steam Locomotive Accident

	Year ended June 30									
	1942		1941		1940		1939		1938	
	Killed	Injured	Killed	Injured	Killed	Injured	Killed	Injured	Killed	Injured
Members of trains crews:										
Engineers	10	79	5	41	5	70	4	46	3	70
Firemen	12	73	5	68	6	49	6	66	2	80
Brakemen	4	32	3	21	4	24	2	18	..	31
Conductors	..	7	..	8	1	4	..	5	..	6
Switchmen	..	5	..	6	..	4	..	6	..	7
Roundhouse and shop employees:										
Boilermakers	2	4	..	..	1	3	1	1	..	2
Machinists	..	5	1	3	..	3	..	2	..	..
Foremen	..	1	..	2	..	..	..	..	..	1
Inspectors	1	2	..	..	..	..	..	..	..	1
Watchmen	..	..	1	2	..	1	..	1	2	..
Boiler washers	..	..	..	..	..	..	..	..	..	1
Hostlers	..	4	..	3	..	2	..	1	..	6
Other roundhouse and shop employees	3	3	..	1	..	1	..	2	..	1
Other employees	2	3	..	9	1	20	..	2	..	3
Nonemployees	..	9	..	18	..	44	2	14	..	7
Total	34	227	15	182	18	225	15	164	7	216

to the running gears but the force of the explosions caused derailments. Three employees were killed and four employees injured in an accident that occurred while the locomotive was in the enginehouse; the rear end of the locomotive was lifted from the rails and dis-

spected were found with defects or errors in inspection that should have been corrected before the locomotives were put into use; this represents a decrease of one per cent compared with the results obtained in the preceding year. There was a decrease of nine in the number of

Table IV—Number of Casualties Classified According to Occupation—Locomotives Other Than Steam

	Year ended June 30									
	1942		1941		1940		1939		1938	
	Killed	Injured	Killed	Injured	Killed	Injured	Killed	Injured	Killed	Injured
Members of train crews:										
Engineers	..	5	..	1	..	2	..	3	..	3
Firemen	..	2	..	5	..	2	..	1	..	..
Brakemen	..	1	..	1	..	..	..	1	..	..
Conductors	..	..	..	1	..	1	..	..	..	..
Switchmen	..	1	..	..	..	1	..	..	..	1
Maintenance employees	..	..	..	2	..	1	..	..	..	..
Other employees	..	..	..	..	..	..	..	..	..	..
Nonemployees	..	..	..	1	..	..	..	..	..	..
Total	..	9	..	11	..	7	..	5	..	4

placed sidewise and parts of the enginehouse were wrecked. Four employees were killed and five employees injured in the remaining five accidents, in which the explosions were less violent than those described in the foregoing.

The serious results of boiler explosions are well known to railroad men and explosions have been materially reduced since the inception of the Boiler Inspection Act; however, there has been an increase in such accidents in the past two years with consequent increased loss of life and injuries and destruction of equipment.

Many locomotives are equipped with protective devices such as syphons, multiple drop or fusible plugs, and low-water alarms, all of which have no doubt prevented boiler explosions or minimized the severity thereof. Carriers that are continuing to make applications of devices of this character are making a distinct contribution to the conservation of human resources and equipment.

Boiler and appurtenance accidents other than explosions resulted in the deaths of seven persons and injuries to 65 persons; this is an increase of six deaths and 30 injuries as compared with the accidents of the preceding year.

Extension of Time for Removal of Flues

One thousand and seventy-nine applications were filed for extensions of time for removal of flues, as provided in Rule 10. Investigations disclosed that in 57 of these cases the condition of the locomotives was such that extensions could not properly be granted. Twenty-eight were in such condition that the full extensions requested could not be authorized, but extensions for shorter periods of time were allowed. Forty-six extensions were granted after defects disclosed by our investigations were required to be repaired. Twenty-seven applications were canceled for various reasons. Nine hundred and twenty-one applications were granted for the full period requested.

Locomotives Which Are Propelled By Power Other Than Steam

There was a decrease of two in the number of accidents occurring in connection with locomotives other than steam and a decrease of two in the number of persons injured as compared with the preceding year. No deaths occurred in either year.

During the year five per cent of the locomotives inspected were found with defects or errors in inspection that should have been corrected before the locomotives were put into use; this represents a decrease of one per cent compared with the results obtained in the preceding year. There was a decrease of nine in the number of locomotives ordered withheld from service by our inspectors because of the presence of defects that rendered the locomotives immediately unsafe.

Locomotive Boiler Specification Cards and Alteration Reports

Under Rule 54 of the Rules and Instructions for Inspection and Testing of Steam Locomotives, 312 specification cards and 8,241 alteration reports were filed, checked, and analyzed. These reports are necessary in order to determine whether or not the boilers represented were so constructed or repaired as to render safe and proper service and whether the stresses were within the allowed limits. Corrective measures were taken with respect to numerous discrepancies found.

Under Rules 328 and 329 of the Rules and Instructions for Inspection and Testing of Locomotives Other Than Steam, 666 specifications and 316 alteration reports were filed for locomotive units and 99 specifications and 111 alteration reports were filed for boilers mounted on locomotives other than steam. These were checked and analyzed and corrective measures taken with respect to discrepancies found.

Legal Matters

One case of violation of the rules and instructions for inspection and testing of steam locomotives and tenders and their appurtenances, comprising 17 counts, was pending in the district court at the beginning of the year. This case was dismissed upon compliance with the provisions by the carrier and agreement to avoid such violations in the future.

Special Work

In response to requests from military and naval authorities and other Government agencies engaged in the war effort, inspections of various locomotives and work equipment were made to determine the conditions and suitability for the respective uses, and cooperative assistance was rendered in other respects. These locomotives are being generally maintained to the standards prescribed by the locomotive-inspection law and rules governing the condition of locomotives used on the lines of common carriers and inspections are currently made by our inspectors.

No formal appeal by any carrier was taken from the decisions of any inspector during the year.

Table V—Number of Steam Locomotives Reported, Inspected, Found Defective, and Ordered from Service

Parts defective, inoperative or missing, or in violation of rules	Year ended June 30					
	1942	1941	1940	1939	1938	1937
Air compressors	829	584	567	518	689	766
Arch tubes	27	31	20	28	66	105
Ashpans and mechanism	80	67	37	67	72	80
Axles	2	5	3	2	13	10
Blow-off cocks	238	205	191	204	226	199
Boiler checks	393	313	288	279	301	382
Boiler shell	290	271	266	272	331	347
Brake equipment	2,382	1,945	1,506	1,577	2,044	2,322
Cabs, cab windows, and curtains	1,163	1,087	1,078	943	1,226	1,807
Cab aprons and decks	335	307	277	260	326	466
Cab cards	131	97	101	92	109	145
Coupling and uncoupling devices	70	74	53	60	73	74
Crossheads, guides, pistons, and piston rods	1,273	858	815	739	905	1,160
Crown bolts	75	97	54	47	59	76
Cylinders, saddles, and steam chests	1,514	1,332	1,320	1,232	1,645	2,206
Cylinder cocks and rigging	521	438	447	418	585	729
Domes and dome caps	112	94	78	90	109	101
Draft gear	651	620	508	450	740	522
Draw gear	369	347	306	360	479	560
Driving boxes, shoes, wedges, pedestals, and braces	1,743	1,348	1,243	1,330	1,688	1,637
Firebox sheets	255	224	191	238	244	371
Flues	178	150	147	165	159	225
Frames, tailpieces, and braces, locomotive	869	863	665	708	1,001	1,053
Frames, tender	86	83	78	71	131	120
Gages and gage fittings, air	193	183	132	155	230	261
Gages and gage fittings, steam	263	236	211	226	279	324
Gage cocks	497	373	400	361	451	538
Grate shakers and fire doors	491	430	273	252	403	470
Handholds	378	433	333	349	405	510
Injectors, inoperative	47	39	30	26	26	38
Injectors and connections	2,220	1,882	1,330	1,457	1,784	2,020
Inspections and tests not made as required	8,186	7,215	6,218	6,645	8,204	9,638
Lateral motion	498	357	313	243	325	446
Lights, cab and classification	131	50	49	50	48	90
Lights, headlight	218	190	180	177	257	313
Lubricators and shields	234	196	185	200	212	254
Mud rings	244	187	213	248	203	272
Packing nuts	689	508	418	408	448	487
Packing, piston rod and valve stem	738	675	660	739	913	1,393
Pilots and pilot beams	188	142	140	104	154	133
Plugs and studs	173	156	156	179	238	238
Reversing gear	411	387	320	317	404	492
Rods, main and side, crankpins, and collars	1,986	1,565	1,199	1,293	1,669	2,348
Safety valves	67	68	61	97	125	132
Sanders	738	490	415	432	536	655
Springs and spring rigging	3,349	2,597	2,174	2,340	2,901	3,172
Squirt hose	67	62	50	75	94	133
Stay bolts	272	239	227	181	211	276
Stay bolts, broken	274	198	271	258	380	542
Steam pipes	290	385	255	285	410	446
Steam valves	150	110	106	115	141	165
Steps	594	555	449	490	631	678
Tanks and tank valves	1,150	952	768	837	955	1,009
Telltale holes	79	59	95	58	67	79
Throttle and throttle rigging	786	688	647	638	685	909
Trucks, engine and trailing	833	636	598	628	762	785
Trucks, tender	786	773	705	665	907	1,018
Valve motion	779	580	506	554	722	798
Washout plugs	569	445	478	487	626	598
Train-control equipment	7	1	2	5	11	12
Water glasses, fittings, and shields	1,133	788	753	690	915	1,049
Wheels	664	536	554	466	577	803
Miscellaneous—Signal appliances, badge plates, brakes (hand)	970	785	564	610	684	759
Total number of defects	44,928	37,691	32,677	33,490	42,214	49,746
Locomotives reported	42,951	43,236	44,274	45,965	47,397	48,025
Locomotives inspected	113,451	105,675	102,164	105,606	105,186	100,033
Locomotives defective	10,970	9,570	8,565	9,099	11,050	12,402
Percentage inspected found defective	10	9	8	9	11	12
Locomotives ordered out of service	474	560	487	468	679	934

Accident Prevention

Because of the increase in accidents Mr. Hall found it advisable again to place emphasis on the following portion of his report of last year:

The practice, still too often indulged in, of applying temporary repairs in the hope that the locomotive will make a successful trip and that more adequate repairs may be applied thereafter when the time is most convenient, has been productive of many failures on the line of road; these failures, in addition to increasing the peril to life and limb of employees and others and increasing the ultimate cost of repairs, result in delays to the trains involved and frequently affect the orderly movement of other trains. Avoidance of failures of locomotives on the line of road is an essential component of satisfactory railroad performance and it is therefore essential that the practice of applying temporary repairs of the character indicated be reduced to the absolute minimum.

Before a locomotive is started on any trip it should be known that all parts and appurtenances are in safe and suitable condition for service rather than to assume, as is sometimes done,

(*Continued on page 79*)

Table VI—Number of Locomotives Other Than Steam Reported, Inspected, Found Defective, and Ordered from Service

Parts defective, inoperative or missing, or in violation of rules	Year ended June 30					
	1942	1941	1940	1939	1938	1937
Air compressors	13	22	8	14	6	6
Axles, truck and driving	..	5	..	1	5	4
Batteries	1	6	1	1	1	4
Boilers	5	4	10	6	6	5
Brake equipment	86	69	50	50	74	97
Cabs and cab windows	27	45	22	36	25	51
Cab cards	20	24	13	18	11	25
Cab floors, aprons, and deck plates	10	14	17	13	8	17
Clutches	1	..	..	..	..	..
Controllers, relays, circuit breakers, magnet valves, and switch groups	12	7	16	13	7	8
Coupling and uncoupling devices	5	2	6	4	4	3
Current-collecting apparatus	1	3	1	5	8	4
Draft gear	19	15	31	17	23	28
Draw gear	3	3	2	4	3	3
Driving boxes, shoes, and wedges	16	36	29	52	16	14
Frames or frame braces	5	1	12	9	37	5
Fuel system	81	62	51	35	47	152
Gages or fittings, air	8	3	1	6	11	1
Gages or fittings, steam	..	..	2	..	..	..
Gears and pinions	4	2	1	2	2	2
Handholds	14	12	6	8	13	11
Inspections and tests not made as required	274	243	207	185	204	237
Insulation and safety devices	3	4	2	4	13	13
Internal-combustion engine defects, parts and appliances	62	54	35	32	26	50
Jack shafts	1	3	7	6	1	..
Jumpers and cable connectors	1	..	..	1	1	2
Lateral motion wheels	..	4	5	1	..	1
Lights, cab and classification	5	2	1	3	2	5
Lights, headlight	1	1	3	4	4	11
Meters, volt and ampere	2	..	4	2	2	1
Motors and generators	16	16	12	19	18	10
Pilots and pilot beams	10	12	10	6	1	7
Plugs and studs	..	..	..	..	..	1
Quills	6	..	4	7	6	3
Rods, main, side, and drive shafts	2	4	2	2	2	23
Sanders	57	56	34	28	37	52
Springs and spring rigging, driving and truck	35	58	50	16	43	36
Steam pipes	..	1	4	..	5	1
Steps, footboards, etc	21	35	22	18	23	13
Switches, hand-operated, and fuses	2	2	3	5	7	2
Transformers, resistors and rheostats	3	3	1	1	3	..
Trucks	28	30	43	33	40	41
Water tanks	1	1	..	1	..	1
Water glasses, fittings, and shields	5	1	1	1	3	..
Warning signal appliances	3	4	..	1	3	2
Wheels	43	28	22	16	11	21
Miscellaneous	14	8	15	10	7	20
Total number of defects	926	905	766	696	769	991
Locomotive units reported	3,957	3,389	2,987	2,716	2,555	2,416
Locomotive units inspected	6,728	5,558	4,974	4,581	4,024	3,615
Locomotives units defective	358	319	298	260	274	328
Percentage inspected found defective	5	6	6	6	7	9
Locomotive units ordered out of service	12	21	16	14	9	24

Experience with

Alloy Steels in Boilers*

By A. G. Trumbull†

THE requirements for large evaporating capacity in locomotive boilers have required the use of larger and larger boilers until a point has been reached where the boiler represents about 27 per cent of the total empty engine weight. In some of the latest freight locomotives the ultimate in weight per pair of wheels has been reached for existing track and structures. The weight of the boiler being so large a proportion of the total engine weight, possibilities are afforded for large weight reductions where the thickness of the plates can be reduced while maintaining the required factor of safety.

A. G. Trumbull

Nickel Steel as a Boiler Material

Among those railroads first to recognize the possibilities in this situation was the Canadian Pacific which realized the value of nickel steel as a material for boiler construction possessing substantially higher unit ultimate strength than the open-hearth carbon steel most generally employed for boiler construction. Subsequent to the use of nickel steel, silicon steel was offered as an alloy designed to accomplish the same purpose as nickel steel and this has been used to a limited extent in this country. The comparison of the physical properties of nickel and carbon steels will indicate the weight reduction which can be effected since this is directly proportional to the ultimate strength of the material. The properties of silicon steel are such that the average hardness range overlaps that of nickel steel so that for all practical purposes any rules for the fabrication of either of these steels would apply to the other.

The production of nickel steel entails some difficulties because of the extremely adherent scale properties of this material. This causes rough and pitted surfaces of large areas of the finished plate, a condition requiring special mill treatment in the rolling operations in order to avoid extreme pitting and consequently the possibility of a partial loss of the advantages gained from the higher tensile properties.

As is usual with any steel, the increase in tensile strength is accompanied by an increase in hardness and a loss in ductility. Reference to the table of comparisons shows that in the case of the two alloys under consideration, the hardness, as measured by the Brinell readings, is increased about 50 per cent over carbon steel, which naturally introduces difficulties in fabrication. Since with the termination of war it is probable that an era of great advancement in the mechanic arts will follow, we believe it can be anticipated that more attention will be given to efficiency in the design of all mechanical equipment, alloy steels for all purposes will be more generally employed, and, particularly, greater care will be exercised in order to insure maximum value from the use of carbon as well as alloy steels. The fabrication of alloy-steel boilers thus should become a subject of current interest in preparation for the probable extended future use of these alloys.

One of the important problems in locomotive boiler operation has arisen because of the phenomenon now known as intercrystalline corrosion, the cause and effects of which have been discussed at earlier meetings of the Master Boiler Makers' Association. Among the remedies advocated for the correction of this difficulty is a reduction in the stresses to which boilers are subjected both because of steam pressure and because of mechanical conditions arising during fabrication. The measures advisable to meet this condition are applicable whether carbon steel or alloy steels are used in the construction, but since alloy steels naturally involve higher unit stresses, consideration should be given in the design to a reduction of these stresses, particularly in the connection plates; that is, in the circumferential and horizontal seams which are the most frequent locations of difficulties from this cause.

Increased stresses permitted by the higher tensile strength of alloy steels suggested as the cause of aggravated intercrystalline corrosion — Effects of the increased hardness on fabrication of plates and the quality of driven rivets

The committee is of the opinion that all circumferential seams should be triple riveted and all horizontal

* The substance of a report on Topic No. 5 prepared for the 1942 year book of the Master Boiler Makers' Association.

† Mr. Trumbull, chairman of the Committee on Topic No. 5 of the Master Boiler Makers' Association, is chief mechanical engineer, Advisory Mechanical Committee, Chesapeake & Ohio, Cleveland, Ohio.

seams should be designed for relatively low efficiency. A reduction of stresses in these seams also can be effected through the use of carbon-steel instead of nickel-steel rivets. Not only can a reduction in stresses be thus obtained, but a more favorable condition for internal caulking of the horizontal seams results because of the possible reduction in rivet spacing in the outside rows of rivets in the inside welt strip. By low-efficiency horizontal seams is meant such minimum efficiency as will produce the required factor of safety with the customary allowances for deterioration.

The increase in hardness already mentioned introduces difficulties in fabrication involving skill, time, and material, all of which naturally increases the cost of production. In addition to the surface conditions already mentioned, alloy-steel plates have a glossy hard surface, difficult to penetrate, making it necessary to reduce the speed of the drills in order to maintain the necessary cutting edges and to reduce breakage. This condition is, of course, more pronounced with large holes—that is, holes above 1 in. in diameter. Thus, additional time over ordinary carbon-steel drilling is required, both for changing drills and for obtaining other drills newly ground. It should be observed here that an increase in the hardness of rivets requires higher driving pressures and these pressures in turn produce increased wall pressure on the rivet holes, thus tending to aggravate any tendency toward intercrystalline corrosion introduced by water conditions.

A Comparison of Physical Properties of Nickel and Carbon Steel

	Nickel Steel	Carbon Steel
Tensile strength, lb.	70,000-80,000	55,000-65,000
Yield, lb.	.55 Tens.	.50 Tens.
Elongation in 8 in., per cent	1,890,000 Tens.	1,500,000 Tens.
Reduction in area, per cent	3,600,000 Tens.	.....
Hardness (actual) Brinell	160-180	110-120

Difficulties of Using Nickel-Steel Rivets

In addition to other factors affecting rivet material, it should be observed here that experience with nickel-steel rivets has not been altogether satisfactory for reasons other than those mentioned. In certain applications that have been made nickel-steel rivets failed both in the shank and under the head. The exact reason for these failures was not determined, although a number of factors were present which might have been contributory to them. The rivets in question were heated with electric contact induction heaters which were operated at the lowest possible temperature. About 2 min. of heat were required for 1-in. rivets and 2¾ min. for 1¼-in. rivets, the temperature being controlled within a range of 1,500 to 1,700 deg. F. A check of these rivets as heated for driving showed those of the larger diameter running from 1,600 to 1,700 deg. F., although experience demonstrated that it was necessary to maintain the temperature as near as possible to 1,700 deg. The rivets heated to temperatures lower than this did not upset properly on the head end. These rivets were all driven on a bull riveter within a pressure range of from 70 to 97 tons, which was held from 10 to 12 sec. During this interval it was necessary to run water on the dies to keep them cool and it is probable that some water ran over the rivet heads, thus producing a quenching effect which may have been responsible for some of these heads ultimately failing in service. Some of the rivets also cracked in the shank due probably to lack of uniformity in heating; that is, failure to obtain a good soaking heat such as could be produced by using coal, oil, or gas for heating purposes.

This experience indicates one of the difficulties encountered with alloy steel which requires greater care in heating and cooling than open-hearth steel. The condition of the interior of the rivet under the head is indicated in a general way by the hardness of the material which is indicated by the table at various locations in the head and shank of both defective and non-defective rivets selected at random.

Examination further developed as many as five or six fractures in the rivet shanks, a condition not present in the original rivets as manufactured which indicates that conditions responsible for the damage were created either in heating or in subsequent working.

Failure of these rivets in the shank and under the head naturally reduced their holding power, thereby permitting excessive movements of the sheets in the areas affected, thus contributing to the failures of the plates which followed. Experience with an identical boiler in which carbon-steel rivets were substituted for nickel-steel rivets has failed to disclose similar difficulties since no trouble has developed after twelve years of service under similar operating conditions.

Problems of Fabrication

The difference in hardness is also reflected in finishing the edges of the plates for caulking and, consequently, in the planing operation the cutting speed must be greatly reduced since the outer surface of the edge of the plates is extremely hard and tough due both to the material and to the condition produced by the cutting of the plates to the required size for planing. This naturally affects the cutting edges of the tools, which necessitates a frequency of grinding greatly in excess of that of tools used in planing carbon steel.

The harder material also involves greater care and a greater number of passes in the rolling operation, since it is necessary to avoid too rapid forming of the plates. This obviously requires more time with a consequent increase in the cost of the operation.

In flanging alloy-steel plates, whether by dies or by hand, it is necessary to use substantially higher tem-

Hardness Characteristics of Driven Nickel-Steel Rivets

A survey on longitudinal faces cut through the centers of two failed rivets and on longitudinal faces cut through the centers of two non-defective rivets—Readings taken on a Rockwell hardness tester "B" Scale and converted to Brinell.

	Average Brinell hardness values					
	From surface of head, in.			Base of head across shank	From surface of shank, ⅛ in.	Along center of shank
	⅛	¼	⅜			
Failed rivet No. 1:						
Outside head	230	201	176	179	...	...
Inside head and shank	205	182	179	192	193	196
Average hardness, 193 Brinell						
Failed rivet No. 2:						
Outside head	211	191	177	197	...	...
Inside head and shank	200	186	181	186	190	190
Average hardness, 191 Brinell						
Non-defective rivet No. 3:						
Inside head	210	196	191	219*	...	...
Outside head and shank	186	177	175	184	194	204
Average hardness, 193 Brinell						
Non-defective rivet No. 4:						
Inside head	201	190	186	210*	...	...
Outside head and shank	194	179	173	179	189	191
Average hardness, 189 Brinell						

* Increased hardness due to work hardening when head was removed.

peratures, thus increasing the time of the operation about 20 per cent. If relatively high temperatures are not used, it becomes necessary to use two heats and two operations in pressing when die flanging is used, since the toughness of the alloy steel renders forming extremely difficult.

Where no dies are available for flanging, and the work is done by mauls, the length of time is greatly increased on account of the necessity for working the metal at high temperature which is necessary because this steel is more susceptible to failure when worked at low temperatures than is the case with carbon steel. The requirement for flanging at high temperatures reduces the available working time, since the metal cannot be worked below certain temperatures. This naturally involves a considerable increase in the heats for each plate, thus increasing the time and labor involved for the different flanging operations.

Greater care is also required in fitting the plates or parts together since, in order to secure a metal-to-metal fit within the prescribed tolerance of .003 in., each section of the plate must be heated and laid up closely by the use of flatters and mauls. These plates require greater care in fitting than is necessary with carbon-steel plates, making it necessary to apply temporary bolts in each hole in any seam that is being fitted in order that the plates may be firmly held in place until they have cooled off, since after heating for the setting-up operation the plates will spring apart when cooling begins. It can be readily understood that the use of plates requiring special heating and fitting naturally results in reducing the rate of production with a corresponding increase in the labor cost.

Progress Report on the Gas-Turbine Locomotive

(*Continued from page 73*)

An improvement in the full load efficiency of any gas-turbine power plant depends primarily on the availability of metals which will permanently stand higher gas temperatures and still can be machined by ordinary means. Due to the lack of such steel alloys for commercial purposes in Switzerland about three years ago—which lack continues to this day on account of the war—all the gas turbines built by Brown, Boveri in 1939 and since that time were designed for a maximum gas temperature at the turbine inlet of 1,112 deg. F.

Development work on materials which can stand higher temperatures has, of course, been going on for some time in various countries and has, no doubt, even been speeded up by the requirements of war production. It is thus a safe prediction that materials for higher temperature work will be commercially available after the war.

An increase in the allowable continuous gas temperature at the turbine inlet will immediately bring favorable results in the overall efficiency of the gas turbine. Not only will the temperature drop through the gas turbine and thus its output be increased, but at the same time the quantity of air needed for cooling the hot combustion gases down to the temperature limit permissible for the turbine, will be proportionately reduced, thus also reducing the power consumption of the compressor. As the net output of the gas turbine is the difference between the power developed at the gas-turbine coupling and the power consumed by the air compressor, there will be a double gain from any allowable increase in the temperature and the overall-efficiency will increase at a rate about double that of the temperature.

It has been noted that the maximum thermal afficiency of the gas-turbine power plant on this locomotive is about 18 per cent at about three-quarter load. If a gas temperature of 1,500 deg. F. can be allowed at the turbine inlet, the thermal afficiency will immediately increase to 29 — 30 per cent, i.e. it comes very much nearer that of a Diesel-electric unit.

Mr. Herold doubts whether the difference in fuel cost between Diesel oil and Bunker oil is in the ratio of 2:1, but I have figures from a survey undertaken about fuel costs in the major ports of the world by several large European shipping companies, before the war started. This survey shows average fuel costs as follows: If the cost of bunker oil is taken as 1, the cost of gas oil is 2.09 and that of Diesel oil 2.26, all based on the same weight.

It is true that the net output of a gas-turbine power plant varies with the temperature of the surrounding air. This is particularly due to the inherent characteristics of the axial compressor. Its power consumption increases with the air temperature thus leaving a smaller effective output of the power plant, but the reverse is also true. When the gas-turbine locomotive is operated during winter time with its lower average air temperature, the extra output obtained from the gas turbine will be more than sufficient for electrically heating the entire train. On railroads where electric train heating is not in general use this extra energy could, of course, easily be converted into steam through an electric boiler installed on the locomotive.

On runs across high mountain ranges the gas turbine will again develop more power as it reaches higher altitudes, which is a most desirable feature for negotiating the grades. For example; if the net output of the gas turbine is 2,000 hp. at 68 deg. F air temperature, it will be about 2,600 hp. at 32 deg. F. and about 3,280 hp. at minus 4 deg. F.

Locomotive Inspection Report

(*Continued from page 76*)

that if the locomotive arrived under its own power it can go out again. All parts to which repairs have been made, the condition or capacity of which may not be determinable by visual inspection, such as air compressors, injectors and feedwater pumps, should be appropriately tested for the output required under service conditions in addition to the usual examinations made when a locomotive is being prepared for service, since mere observation that these parts "work" when a locomotive is at the terminal is not sufficient to determine whether or not their capacity has been restored. In investigations of accidents we sometimes find reports on the defect that caused the accident repeated many times until failure eventually occurred, together with signatures on the reports indicating that the reported work had been done, or at least that repairs to the reported defects had been attempted each time a report was made. This is proof that the safe repairs required to secure dependable operation of the locomotive had not been made and that labor and time had been wasted.

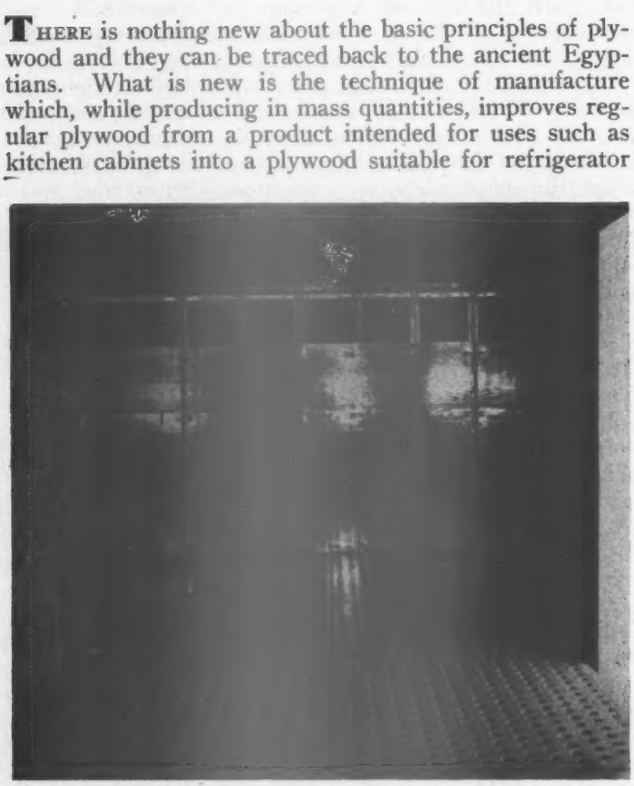
Complexity of the various appurtenances installed on modern locomotives, coupled with the placing in service of a large number of older locomotives which have been out of service for periods ranging up to 10 years or more, many of which are practically obsolete and therefore not well adapted to the giving of satisfactory performance under present conditions, and the intensive use of all locomotives now in service necessitate increased vigilance on the part of all concerned.

[The report included recommendations for salary increases for the director, two assistant directors and the district inspectors; also for the provision of five additional district inspectors.—EDITOR.]

Plywood Refrigerator Cars*

By Harry A. Dodge†

THERE is nothing new about the basic principles of plywood and they can be traced back to the ancient Egyptians. What is new is the technique of manufacture which, while producing in mass quantities, improves regular plywood from a product intended for uses such as kitchen cabinets into a plywood suitable for refrigerator cars and heavy construction, including marine and other wartime exterior applications where it is for the present almost exclusively used.



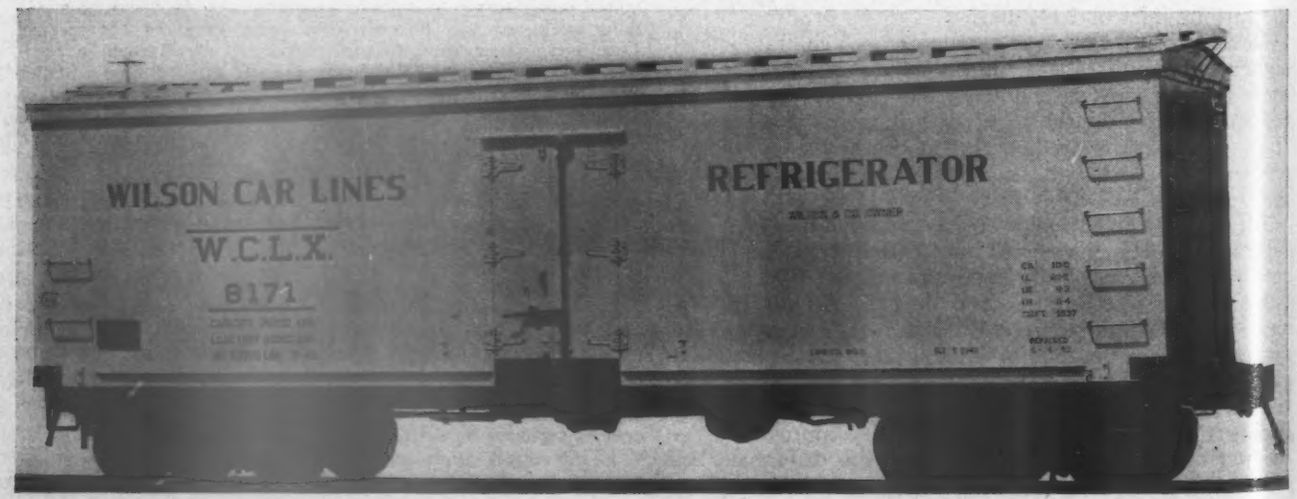
Refrigerator car built with plywood inside lining

The most important point in connection with the successful use of plywood in refrigerator cars or any railway equipment is that the proper type of plywood be selected. Plywood, regardless of type, of which there are many, consists of an odd number of veneers bonded together with the grain of each adjoining ply at right angles to the other and, although the appearance may be basically the same, we have to go into the technique of manufacture to really determine if it is suitable. A responsible plywood manufacturer has no desire to supply a plywood not intended for the use to which it will be put, and the manufacturer's recommendations should always be observed.

I am going to refer briefly to the basic technique used by the Harbor Plywood Corporation in manufacturing plywood in the Pacific Northwest, in accordance with the requirements for exterior type Douglas fir plywood in the United States commercial standards plus rigid individual requirements as set up by our engineers and production men. The manufacture of this plywood was first started in 1935, at which time applications were made to determine its performance in refrigerator cars. These applications were highly successful and, from that time on, progress has been rapid and performance has been almost beyond expectations. This plywood is the best that we can produce to resist decay and the effects of water and weather, and is a plywood of scientific development which comes more in the category of being an engineered lumber than just plain plywood.

How Plywood Is Manufactured

The logs are cut into desired lengths which results in what is known as peeler blocks. The peeler blocks are cut into veneer on a rotary-type lathe which revolves the peeler block against long, sharp knives. This action results in a flow of veener emerging from the machine in a continuous sheet in much the same manner as unwinding a roll of news print. Following this operation, the veneers are cut to desired widths in a clipper machine



Plywood refrigerator car built in 1940

* Abstract of a paper presented at the December 14, 1942, meeting of the Car Foremen's Association of Chicago.

† Sales engineer, Harbor Plywood Corporation, Chicago.

and subsequently dried to the proper moisture content. Particular care is given the drying operation so that the strength and the tenacity of the wood fibers are not damaged.

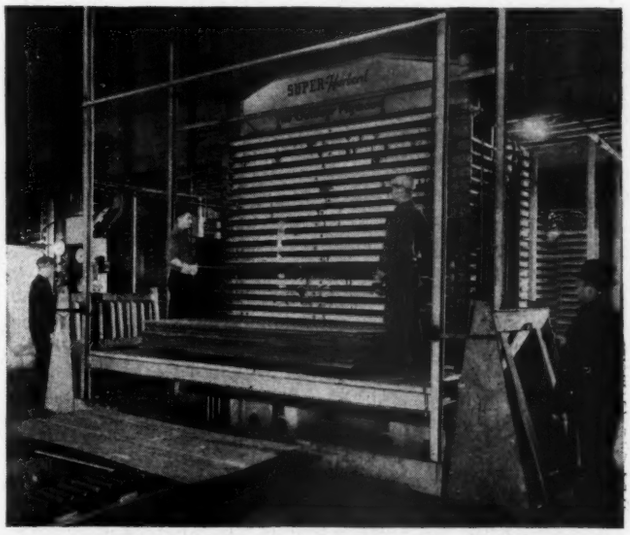
It is an accurately controlled system, insuring the uniform exhaustion of moisture and the setting of natural resins. The operations up to this point in the manufacture are basically the same, regardless of the type of plywood to be manufactured with the exception that the moisture content required and the thickness of veneer required for a given thickness of plywood are usually different.

To make the proper type of plywood, the most important operation, following the cutting and drying of veneers, is the laminating or fusing process. Under controlled conditions a weatherproof thermosetting phenolic or cresylic-formaldehyde-type synthetic resin is spread on the inner cross plies in a pressure-roll-coating machine. The panels are temporarily assembled and, following this, are put into giant hydraulic hot-plate presses, with each panel separated between hot plates. The pressure and heat in the press are applied simultaneously, and this causes the binder or resin to fuse the veneers together. The panels must be held in the press for a certain period under certain definite temperatures to properly fuse the resin. This lapse of time has a tremendous effect on production and cost, and it would be possible to shorten this time by the use of other types of resin, but we have not yet been able to get equal performance out of them. This, along with other operations, is done under full laboratory supervision and results in a bond which is unaffected by moisture and which is stronger than the wood itself.

Hot-Press Panels Must Be Tempered

It has been our finding that the hot-plate press operation often results in an unbalanced moisture content and, panels put into the field in this condition are subject to warpage due to contraction and expansion. In view of this, the panels are put through a tempering or humidification process where, under thermally controlled conditions, moisture is put back into the panel in such a way that it balances the moisture content between opposing veneers. This corrects the normal possibility of warpage and gives the panels proper moisture content, to permit the car builder to apply them without allowing for contraction and expansion.

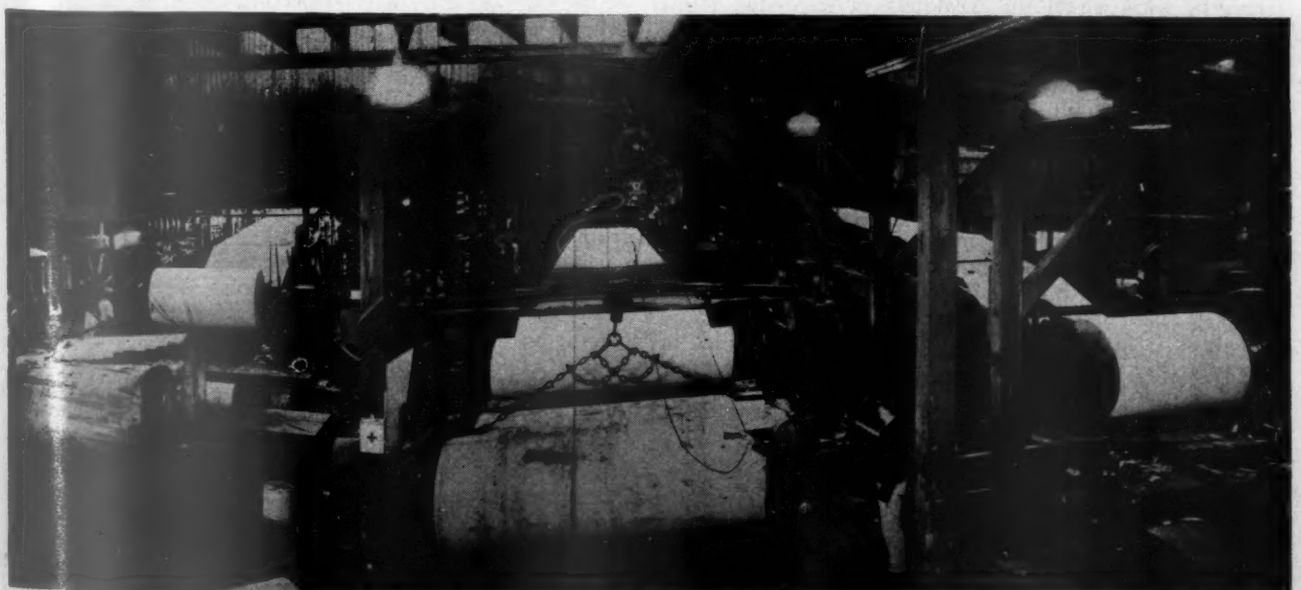
Following the humidification process, the edges of the panels are accurately trimmed to close tolerances, and the faces are sanded when specified. The final step is a very rigid and close inspection prior to shipment. These are conducted in the laboratory at regular intervals to determine performance. The edges of the panels, made under this process, are branded with the identifying, burned-in, trademark "Super Harbord," and a distinctive green binder line between the veneers serves as a protection for both user and manufacturer. By mutual cooperation, especially in the last five or six years, and a better understanding of each other's problems, the car builder has been able to develop his specifications and applications to better advantage, and the mill has been able to improve its product.



Hot-plate press used in making plywood panels

Kind of Plywood Used In Refrigerator Cars

Since Super Harbord plywood was first used in refrigerator cars, in 1935, there have been thousands of



The beginning of plywood—The log-peeling machine

additional applications for repairs to cars, and hundreds to new or rebuilt cars, in the latter cases, plywood being generally used for all-over construction. The performance of these cars has been watched closely and the differences in technique or system of application used by the various builders are slight. It is felt that even these slight differences will be eliminated as time goes on. We are encouraging standardization as nearly as possible, considering the many types of refrigerators in operation. Among those who have built all-plywood cars are the General American Transportation Corporation, Fruit Growers Express Company, Wilson Car Lines, North American Car Corporation, St. Louis Refrigerator Car Company, and the Pacific Fruit Express Company. The co-operation received from these concerns and many others using plywood has been highly gratifying.

Reports on the advantages of plywood in refrigerator cars are numerous and I will attempt to give you a brief outline of some of these findings. Because the material is wood, it has a low heat conductivity and is, therefore, a suitable material for refrigerators. It comes in large sheets, and it is possible to build with few or no unsupported joints, which ordinarily permit free passage of vapor. One company, building 40-ft. all-plywood cars, has eliminated 86.5 per cent of the linear footage of joints, compared with tongue and groove construction. This makes it an ideal housing for insulation because the insulation is kept in a dry condition. Also the type of resin binder used tends to reduce vapor transfusion through the material.

In still another program of all-plywood cars, the number of pieces per car has been reduced about 89 per cent and only 3.6 per cent as many holding screws and nails are required as in conventional tongue-and-groove construction. This elimination of parts greatly increases the strength of the car and reduces construction time.

Savings in dead haul weight of as high as 6,124 lb. have been made in 40-ton refrigerator cars, compared with conventional tongue-and-groove construction. This saving is due to a reduction in material weight and in the number of framing members previously required to give the car strength. As time goes on, it is possible that the weight reduction, through elimination of excessive framing, will be greatly increased. It is readily appreciated that large sheets of material, such as this, provide a diaphragm, or stressed covering type of strength, with which the weakness of excessive joints can be eliminated.

Refrigerator cars involving all-plywood construction have been built at costs comparable with conventional wood cars. In some parts of the cars, the cost of material may be slightly higher. Where this occurs, it can be offset by increased production and a lower cost for other car parts. In some details such as tank linings and roof structure, it has been possible to reduce greatly the thickness of material, compared with conventional wood construction, and at the same time give the car more of the type of strength it really needs. A sheet material properly applied, particularly in the roof structure and side walls is far more valuable, from the standpoint of strength, than heavy bulk thickness.

The Question of Repairs

The subject of repairs to damaged sheathing has come up, and the answer to this is to either replace the entire panel, or to make repairs to the damaged portion of the panel. New types of plastics are available which make it possible to permanently repair a surface scar without removal of the sheet. It is also possible to cut clear through the panel, removing the damaged part and repairing the panel without removing it from the car. This technique will be fully and more completely developed later, as it becomes necessary, and I am only making mention of the matter so that you will realize full consideration is being given the repair problem. We must keep in mind that this material is wood and that wood is always easily worked, and with just ordinary hand tools.

In addition to the applications to all plywood refrigerators, the car builders I have mentioned, together with several other leading companies, are making good use of the material in various parts of new cars, and in repair cars. Some companies find it more suitable for linings or top floors and others find it desirable for siding; still others for end bulkheads, depending upon their particular problems.

Plywood-Lined Cars Are Cinder Tight

Perhaps the most outstanding applications to repair cars have been the methods used to eliminate cinder leakage. This has been an important development and about five different companies are using the material for this purpose. In case, it is possible to remove the roof and get into the carlines of the car, the most acceptable method is to apply the plywood over the tops of the carlines, breaking the panel joints at a carline aproximately every eight feet. The panels are nailed in place at the carlines, center ridge and side plate and, because there are so few joints and none of them unsupported, it is unnecessary to take additional precaution. However, the joints are usually caulked with a suitable mastic, or other methods are used, as additional insurance against cinder leakage.

In the majority of cases it is impossible to remove the roof and make repairs along the lines I have described and, where this is the case, the most popular method is to apply a secondary ceiling of thin plywood direct to the old ceiling. The panels used are usually 48 in. wide and they are applied in one long length, stretching from side to side, extending over the side wall lining boards. A strip of paper is applied around all edges of the panels between the panels and the original ceiling. Short nails are used on about 12-in. centers intermediate and about 6-in. centers at the panel edges. This system, of course, does not keep cinders out of the car itself. However, it is found that it does, when properly applied, minimize leakage of cinders into the body of the car. I have made inspections of 40-ft. cars where after a comparatively short time it was necessary to use shovels and wheelbarrows in removing the cinders that would have ordinarily passed on to the lading and probably resulted in damage claims by shippers.

In other cases, as a precaution against cinder leakage, car builders remove the entire original ceiling and replace it with a heavier, more permanent thickness of plywood. This is usually applied in one long length from side to side with the cross joints breaking at the carlines.

[At the conclusion of his address, Mr. Dodge presented a patriotic all-color, all-sound moving picture, "Food For Total Security," recently made for the Harbor Plywood Corporation, which illustrated in a striking way the remarkable contribution of the railroads and private refrigerator car companies to the war progam by supplying food required for military forces and defense workers, as well as the balance of the civilian population. The film also showed at some length the technique used in constructing 100 all-plywood refrigerator cars in the Los Angeles, Cal., shops of the Pacific Fruit Express Company in the fall of 1940, and the application of plywood to the interior of a series of steel refrigerator cars.—EDITOR.]

EDITORIALS

Beware of the Empty Water Glass

In times of stress like the present carelessness finds many points in routine practice at which the defenses against its insidious pressure are growing weak. This is nowhere more serious than in connection with the handling and maintenance of locomotive boilers. The following message from John M. Hall, director, Bureau of Locomotive Inspection, therefore, seems to us of such importance to all railroad men whose duties require them to be around live locomotives that we place it among the expressions of opinion for which we are solely responsible.

During the first years of the operation of the Locomotive Boiler Inspection Act, a large number of boiler explosions occurred. However, due to the careful policing of the Bureau of Locomotive Inspection, as well as compliance with the requirements of the law and rules, locomotive boiler accidents decreased approximately 95 per cent until the fiscal year 1939 when but six boiler explosions occurred. Such accidents are now increasing and since July 1, 1942 to date, 17 explosions have occurred which resulted in the death of 14 experienced enginemen, firemen and trainmen, and seriously injuring 46 others.

Death or serious injuries are most regrettable at any time, especially to the person's immediate family, but when manpower is so vitally needed on our railroads these accidents are most unfortunate, and in addition the resultant damage and loss of service of locomotives to the railroads is also a most serious condition, the repairing of which consumes needed material and man hours.

Our inspectors make a most thorough investigation of all accidents coming under the law and that is especially true of boiler explosions. Our reports will show that crown sheet failures which resulted in explosions have been caused by defective fireboxes, mud and scale on the crown sheet, bad water, defective water glasses, etc., but the sad part is that most locomotive boiler explosions are due to low water.

Why does the water become low? Except in a few instances, no one knows why. It may be a mental lapse, or the engineman may be misled; for instance, he may mistake an empty water glass for a full one; the worn condition on the water side of reflex type glasses may fool him; the water glass lamp may not be properly located causing the glass to appear full or partly full, when it may in fact be entirely empty. The top water glass valve may be closed or the bottom connection stopped up. All experienced enginemen know that the water in the glass is never still if it is functioning properly. If the water is still the drain cock should be opened, the bottom water glass valve closed and if time permits, close the top valve, then close the drain cock and open the top and bottom valves the same amount of opening, if all is o.k., then the water should immediately return to the same height and move up and down with a slight movement.

Sometimes in a pinch an engineman will swap water for steam; two such cases which resulted in explosions occurred recently. In one case the locomotive was equipped with a low water alarm; the alarm whistle started to blow, the amount of water was increased in the boiler and the whistle stopped blowing; however, in a short time the low water alarm again sounded and presently the boiler exploded. In another case, the boiler was oil fired; the water was all used out of the tank, the locomotive was cut loose, leaving the train on a hill and locomotive moved light to a water station, the fire extinguished after arriving at the water plug, and after taking water the fire was forced and when the steam pressure increased to about 150 lb., the boiler exploded. In the first case two employees were injured, and in the latter case one was killed and two injured.

Two interesting cases where low water was involved came to our attention recently where the locomotives were equipped with thermic syphons; in one case the water receded to about 25 in. below the highest part of the crown sheet; the sheet did not fail and no personal injuries resulted; in the other case the water was down about 23 in. below the highest part of the crown sheet, but the sheet did not fail; however, due to one or two superheater flues collapsing and partly pulling from the back flue sheet two employees were injured by the escaping steam.

Regardless of the safety devices with which a boiler may be equipped, enginemen should not depend on them to prevent boiler explosions; the water glass and gauge cocks are for the purpose of keeping the engineman and

fireman apprised of the height of water in the boiler, and both should be equally interested in the amount of water in the boiler, *it should be a matter of mutual interest.*

The water should never be permitted to go out of sight in the glass, but if it should, never be so foolish as to close the top water glass to see whether water will show up in the glass. That is most foolhardy, as the bottom connection to the glass or column is several inches below the bottom reading, and so long as there is water at or near the bottom connection the pressure in the boiler will force the water to rise in the glass or column much higher than the actual height of water in the boiler.

Accidents resulting from failure of some part of appurtenance of the locomotive and boiler have increased 50 per cent during the past year; it is apparent that the war is affecting all of us mentally, whether we realize that fact or not, so let us take stock of our thinking and endeavor to be mentally alert at all times, especially when operating locomotives.

Aviators have coined a word for imaginary little spirits that cause plane wings to coat over with ice, stop up fuel or oil lines, etc., which they call "Gremlins." So brother enginemen and firemen, don't let the "Gremlins" fool you about your water—be alert.

A Limitation Removed from A. C. Welding

The development of new electrodes has entirely changed the status of alternating current welding. Whereas the a.c. arc was formerly difficult to use and limited in application, on some work it is now easier to use and there are only a few welding operations which can best be done with direct current. Users believe that a.c. will soon be suitable for all forms of welding.

This change was brought about largely by the production, last year, of a.c. welding electrodes which are satisfactory for welding in the vertical and overhead positions. The inherent advantages of the a.c. welder are thus made generally available. Probably the best feature of a.c. welding is the absence of magnetic disturbance known as arc blow which frequently gives trouble to the operator working with direct current. Other advantages are reduced power consumption (this may be as much as 45 per cent) and reduced maintenance. Since there are no rotating parts, wear is limited to plugs, receptacles and control equipment. Also since the welding transformer is a static device, insulation which will stand higher temperatures can be used.

The cost factor is also important. In small sizes, a.c. welders can be had which cost little more than half as much as d.c. machines. In larger sizes, the question of power factor becomes increasingly important, and it is desirable to include a capacitor. With the addition of the capacitor, the cost of the a.c. machine approximates that of the d.c. unit, but it must be remembered that the use of the a.c. machine has been limited. It requires less material, and if the quantity produced is increased, a reduction in cost should be possible. No one now using d.c. machines will scrap them for a.c. welders, but it seems certain that the percentage of the latter will increase as replacements become necessary and the use of welding is extended.

Signs of Strain

Never before have so large a proportion of freight cars and locomotives been in serviceable condition as during 1942. The number of freight cars undergoing and awaiting repairs was less than 4 per cent of the cars on line throughout 1942 and fell below 3 per cent after the middle of September. It reached a low of 2.4 per cent during the last half of October. The highest percentage of steam locomotives awaiting repairs was 8.6 in February and this came down steadily during each succeeding month to 5.4 per cent in December.

But these percentages leave the question as to the trend in the average condition of the cars and locomotives in service. Are equipment units being continued in service beyond the normal mileage for rebuild or classified repairs? Are running repairs being taken care of currently?

In the annual report of S. N. Mills, director of the Bureau of Safety of the Interstate Commerce Commission, there are three studies which throw some light on the condition of freight cars. The most direct is the per cent of freight cars inspected which were found defective. During the fiscal year ended June 30, 1942, the percentage was 2.55, an increase from 2.46 during both of the two preceding years.

Another index is the number of cases of train and engine crews remaining in the service more than 16 consecutive hours due to mechanical defects in cars. These cases increased from 55 in 1941 to 271 in 1942. Considering air brakes alone, there has been a steady increase in the number of cars set out and in the number which had to be repaired in trains per 100 cars inspected as the result of terminal tests before the departure of freight trains. These two groups combined amounted to 1.32 cars in 1940, 1.65 in 1941, and 1.65 in 1942.

In the annual report of the Bureau of Locomotive Inspection the percentage of steam locomotives inspected and found defective increased from 11 in 1940 to 12 in 1942. The number of defects per defective locomotive increased from 3.82 to 4.00. The percentage of locomotives other than steam inspected which were found defective increased from 7 in 1941 to 9 in 1942. The number of defects increased from 2.8 per defective locomotive in 1941 to 3.02 per defective locomotive in 1942. More significant than these comparisons, however, is a comparison of the number of defects by classes for the past two years. With an increase of 7.4 per cent in the number of locomotives inspected,

there was an increase in the total number of defects of all classes of 19 per cent. Among the large classes of defects, showing rates of increase much higher than the average are crossheads, guides, pistons and rods, 48.3 per cent; water glasses, water-glass fittings and shields, 43.8 per cent; driving boxes, shoes, wedges, pedestals and braces, 29.3 per cent; springs and spring rigging, 29 per cent; and main and side rods, crank pins and collars, 29 per cent.

Taking together all of the statements in the report of the Bureau of Safety which bear on the car conditions, the trends are not sufficiently pronounced to justify the conclusion that there has been any appreciable decline in the average physical condition of freight cars.

In the case of locomotives, the evidence suggests that some decline in the general condition of locomotives had already set in prior to June of last year. This is quite definitely the result of a slight dropping behind in current running repairs and there is some suggestion of a lowering of conditions as the result of mileage extensions between classified repairs. Considering the continued high standard of performance of locomotives during the last half of the calendar year 1942, it is evident that the standards of physical condition of motive power are still high but they must be watched closely.

How Are We Doing?

Just how the railroad man could get along without statistics is hard to imagine. He uses them to prove that he is right and the other fellow is wrong; his boss uses them to prove that things are not going as well as they should and when the going is tough as it is these days, these same good old statistics are often used to provide the consolation that some people need to convince themselves that they are doing well enough.

Take fuel records, for instance. The railroad man has looked upon the figure of pounds of coal per 1,000 gross ton-miles as the measure of the state of things concerning the use of locomotive fuel so long that it will probably be considered rank heresy to question the value of such a figure. The man whose railroad has a fuel figure way down in the 70's or 80's is, like his brother on the golf course, a person to be cultivated in order that one may find out what system he uses to arrive at the place where he can look down off the end of his nose at his less fortunate railroad brethren whose score is up in the 120's or the 140's.

We ran across a fellow the other day who was all riled up because someone had taken a pot shot at the fuel performance record of his railroad and cited his own road's low figure to prove how much better things were over on the XY&Z. Not being the kind who takes things lying down he set out on a campaign to prove that the other fellow wasn't so good either. His research into the question of fuel statistics led him to the early conclusion that if a road had enough gross ton-miles it wouldn't make much difference how much fuel was wasted—one would still have a favorable showing when the lb. per 1,000 GTM figure came out. Further investigations led to another conclusion to the effect that fuel accounting methods left much to be desired if one were trying to determine how efficient the performance might be on individual freight-train runs. So, finally, in desperation he appealed for help in his problem.

The statisticians came up with the accompanying table but like the proverbial prevaricators who toy with figures they couldn't make this one prove that pounds of coal per thousand gross-ton miles had any relation to the efficiency with which fuel was being handled or fired. Here was a problem, indeed: a set of railroad figures that couldn't be used to prove anything you wanted them to prove no matter which side of the

Fuel and Locomotive Performance—Eight Typical Railroads

Road No.		Fuel per 1,000 GTM lb.	Tons of Fuel Used	Loco. miles (000)	Gross ton-miles (000)
1	1938	99	225,460	2,838	586,017
	1942	93	411,092	4,432	1,110,831
	Increase	...	83%	56%	90%
2	1938	96	719,452	6,288	1,815,144
	1942	91	1,198,724	9,104	3,104,383
	Increase	...	66%	32%	71%
3	1938	97	165,594	2,086	466,811
	1942	84	228,262	2,492	667,311
	Increase	...	38%	19%	43%
4	1938	102	2,459,405	24,363	5,467,941
	1942	93	4,398,328	37,689	9,472,468
	Increase	...	80%	55%	75%
5	1938	86	399,731	4,343	984,823
	1942	85	864,037	7,792	2,040,950
	Increase	...	116%	80%	107%
6	1938	101	60,419	565	140,753
	1942	86	163,718	1,122	433,774
	Increase	...	172%	98%	208%
7	1938	76	941,835	7,505	2,239,386
	1942	71	1,407,503	10,548	3,493,446
	Increase	...	49%	29%	56%
8	1938	100	862,712	5,861	1,920,029
	1942	86	1,305,081	8,084	3,084,495
	Increase	...	52%	38%	60%

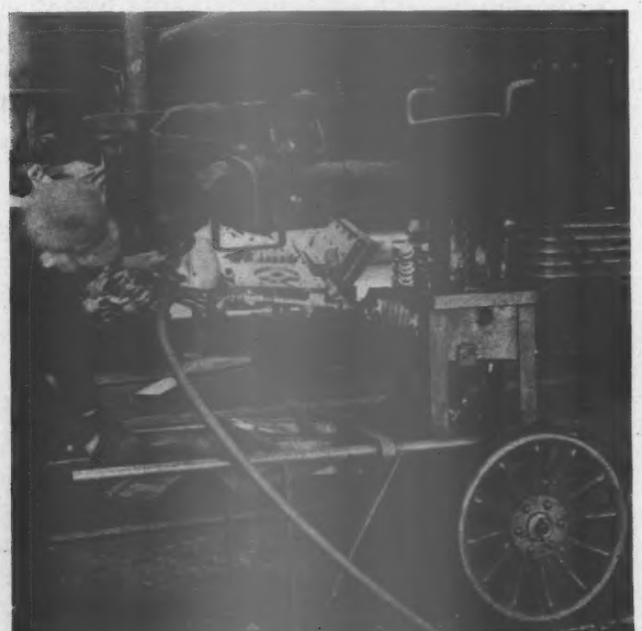
argument you are on. We give you these statistics for what they are worth, proof that if you want a good showing all that is necessary is to burn fuel efficiently and/or have enough business so that you have a good record as compared with some other road, or previous period, in the matter of the gross-ton-mile volume of traffic handled.

We have an idea that many railroad men are deceiving themselves these days with the consoling thought that, just because the fuel performance figures in pounds per thousand gross-ton-miles are going down, they are really doing a job in the matter of fuel conservation. It may be worth while to look into practices of fuel handling and fuel consumption on steam locomotives with a view to finding out whether, during a period of high traffic volume, fuel is not actually being wasted instead of being burned efficiently.

With the Car Foremen and Inspectors

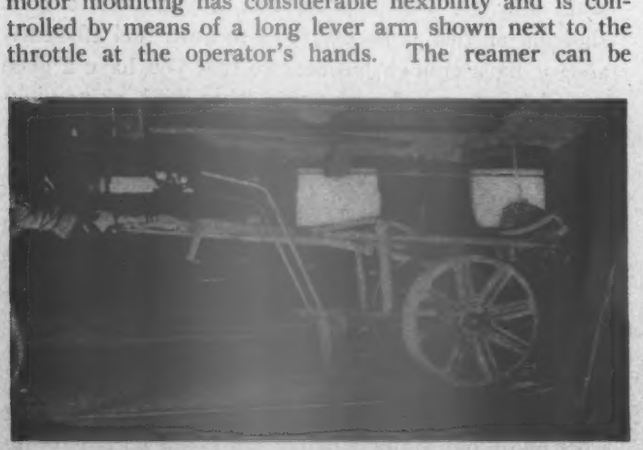
Portable Nut and Reamer Power Wrenches

The devices illustrated are in use in the shops of the Great Northern at St. Paul, Minn. One consists of an air-operated socket wrench for applying or removing the nuts from draft carrier bolts. This socket wrench operates in a vertical position and has a semi-knuckle joint and a high lift, controlled by the operator by means of a long lever. Several sizes of sockets are available.



Portable device for removing carrier-plate holding nuts

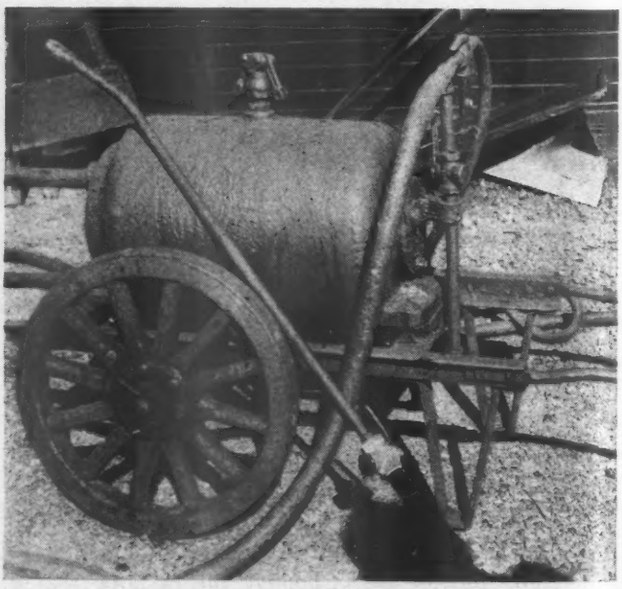
The portable remote-control air reamer is used for reaming center-plate and other underneath holes. The motor mounting has considerable flexibility and is controlled by means of a long lever arm shown next to the throttle at the operator's hands. The reamer can be entered in a hole, the motor started, and the handle of the truck pressed down to complete the reaming operation without the necessity of the operator going under the car.



Portable remote-control pneumatic reamer

Portable Unit for Spray Painting

A portable paint-spraying unit which can be built of scrapped or discarded materials has proved successful in operation at one car repair point. A discarded reservoir with its release valve, from a K-type brake was mounted on a carriage. A sealing plate was applied to the brake-cylinder connection. A pipe connection was then attached to the bottom outlet of the reservoir and a pipe line carried underneath the reservoir and through a bracket attached to the sealing plate. An angle cock is placed in the line at this point and then a tee connection. The yard air line attaches to one of the tee arms and the paint spray line to the other. An additional angle cock is placed in the paint spray line.



A paint spraying unit made from discarded materials

The reservoir is filled with paint through the opening made by the removal of the release valve. The capacity is ten gallons. After the tank is filled the paint spray line is closed at the tee connection and the line pressure of the shop's compressed air is admitted to the tank. When this has been done the paint line is opened at the angle cock and painting proceeds. When the paint in the tank has been used, the air line and paint lines are closed and the air pressure in the tank relieved by the opening of the release valve on top.

Refueling Furnaces Without Interruption

At the shops of the Great Northern at St. Paul, Minn., a large portable tank has been installed on a two-wheel truck, the frame of which is built up of the characteristic pipe sections used in the construction of many devices

A portable tank for refueling small forges

in the car department of that railroad. The high truck frame supports the tank at an elevation sufficient to permit the refueling of small forges and portable rivet heaters by gravity flow. These furnaces can thus be refueled without interruption of their service, and the hazard of filling the furnace tanks from cans is removed.

Some Problems of Tank-Car Maintenance*

By P. J. Hogan†

The carman's alertness is required to cover proper inspection and maintenance of equipment used in the handling of explosives and other dangerous articles by freight and express. His work in this respect reflects credit to him as records indicate that from 1926 to 1939, inclusive, the railroads of the United States hauled these commodities with a perfect record.

The use of tank cars on railroads has reached the peak at this time, and the carman's work has been greatly increased by the needs, inspections and maintenance required by these cars. Records indicate that considerable trouble has been experienced with older cars of this type, due to light construction of couplers, draft gears, brake rigging, excessive slack, neglected maintenance, decayed running boards, tank leakage, periodic air-brake cleaning and jacking and packing of boxes. The tank-car companies should assist the railroads in every way possible to accomplish minor repairs and adjustments to coupler operating levers and lock lifts, the adjustment of piston travel, the application of bolster-spring snubbers, etc. The railroads are working at top speed on repairs to this equipment in order to keep it moving.

The loading companies should do their work conscientiously by leaving the outlet cap off while loading to assure that the outlet valve is operating and tight against leakage. Many defect cards are being demanded by tank owners for loss of safety valves, a great many of them becoming loose and working off. Extreme care must be used by all concerned to guard against a condition of this kind since a spark from an engine is all that would be necessary to start a fire when a safety valve is missing.

It might be well for shippers to guard against freezing of outlet castings by the application of soft wood plugs as many cars will be loaded to the east this winter where temperatures are low.

It has been noticed that some companies are steaming out tanks which had contained gasoline for the purpose of making repairs without properly grounding the brass-pipe steaming apparatus with the tank. Rubber hose should not be used on account of static electrical effect when steam is passing from the hose into or against the tank shell.

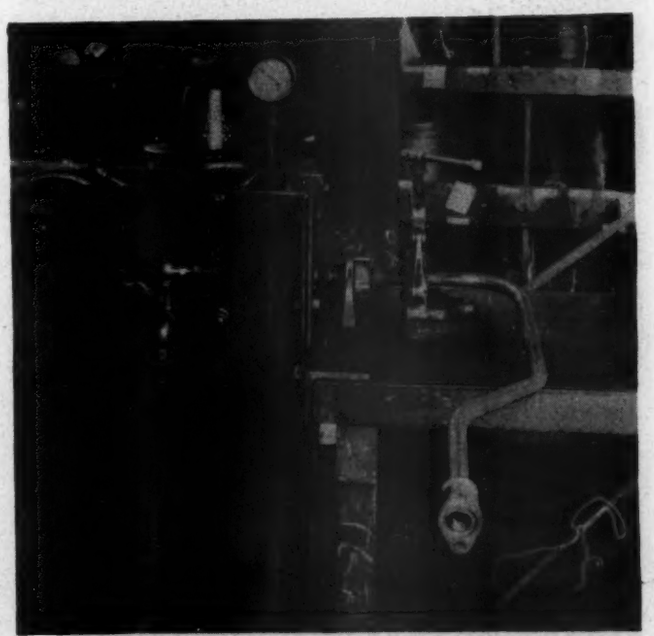
Approved electric lights should also be used on the inspection of cars whether loaded or empty as anything done to produce a spark at the opportune time is all that is necessary for fire or explosion with possible loss of life or property.

* Extract from a paper presented at the November, 1942, meeting of the Car Foremen's Association of Chicago.

† Supervisor car inspection and maintenance, New York, New Haven & Hartford, New Haven, Conn.

Handy Shop Devices For the Air Brake Gang

A flange applicator and a test rack to determine the fit of piping intended for use on AB brake parts have speeded up operations and eliminated the possibility of improperly bent pipe being sent to construction tracks.



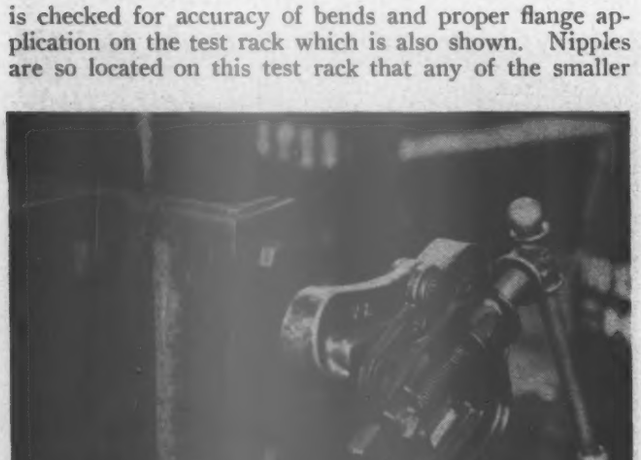
Pipe held in the vise ready for the application of a flange connection

The flange applicator is a simply constructed device which does away with much handwork and insures tight fits on all flanges applied to piping. The piece of pipe to which a flange is to be applied is clamped in a vise and a flange is placed on the head of an air-operated rotating spindle. As the spindle rotates it advances toward the pipe and, when the threads engage, the flange is run up tightly upon the threaded pipe end.

After removal from the flange applicator, all piping

Above: The test rack showing dowel pin arrangement to insure accuracy in pipe bends. Below: Pipe, with flanges applied, mounted on the test rack

is checked for accuracy of bends and proper flange application on the test rack which is also shown. Nipples are so located on this test rack that any of the smaller



Vise and flange holder spindle

bent pieces of pipe may be checked. If the holes in the flanges meet the dowel pins on the rack and the face of the flange is square with the surface of the rack, the prepared pipe section is certain to fit when it is applied on a car.

Air Brake Questions and Answers

HSC High-Speed Passenger Brake Equipment

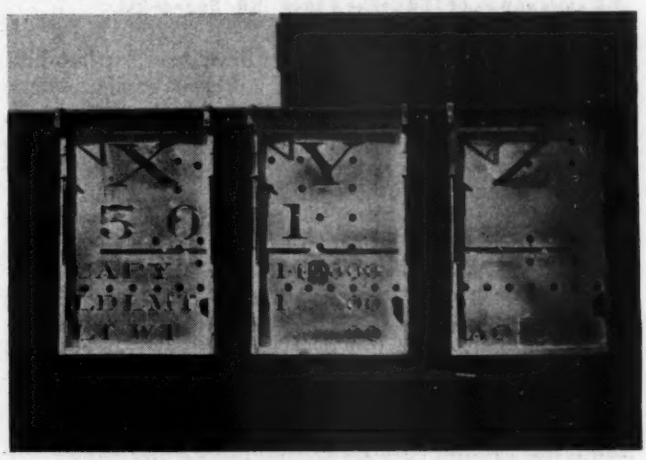
151—*Q.—Explain the operation of the F. S. 1864 or F. 1864 relay valve during an HSC brake application?* A.—At the F. S. 1864 or F. 1864 relay valve, the air from control-valve pipe *16* flows through passage *16* and strainer *17* to the magnet portion and to the diaphragm portion. In the diaphragm portion, the air from passage *16a* flows to the spring chambers of check valves *51, 51a* and *51b,* thence to chamber *A* on 40-per-cent diaphragm *60.* In the magnet portion, the air flows through passage *16b* to chamber *A* of the K-3 switch portion. At approximately 10 lb. pressure, diaphragm *4* of the switch is deflected against the tension of spring *9,* moving collar *6* and closing contact finger *20* across contact holders *28* and *28a,* thus closing the car battery supply wire to the speed-governor relays. The speed governor thereafter energizes or de-energizes the three magnets of the F. S. 1864 relay valve in accordance with train speed. At the inshot-valve portion, application air from passage *16c* flows past the supply valve *92* to chamber *C* on diaphragm *85,* thence to passages *15* and *15a.* From passage *15* the flow continues through chokes *138* and *140,* thence past upper magnet valves *161* and *161b* to passages *18* and *19,* passages *18a* and *19a* to the two diaphragm chambers *N* and *P.* When approximately 7 lb. pressure is obtained in chamber *C* of the inshot portion, inshot diaphragm *85* is deflected compressing spring *88* and moving piston *84* sufficiently to permit spring *94a* to seat supply valve *92,* cutting off further flow to diaphragm chambers *N* and *P.* The 7-lb. initial pressure inshot thus obtained in the diaphragm chamber is directly effective in chamber *P* where it acts on diaphragm *38,* overcomes the resistance of spring *42* and deflects the diaphragm, moving the relay portion to application position. The exhaust valve *23* and its piston *25* are seated by the lever *43,* and the application valve *32* and its piston *30* are opened, permitting the supply reservoir air to flow to the brake cylinders. This provides a low brake-cylinder pressure sufficient to take up the brake-rigging slack and apply the brake shoes to the wheels. After the inshot supply valve closes, the 7 lb. pressure in chamber *P* is retained, thus maintaining this inshot pressure directly on diaphragm *38* while further build-up or pressure in the diaphragm portion is controlled by the position of the magnet valves. At train speeds of less than approximately 20 m.p.h. the speed governor closes the circuit to the low speed (L.S.) magnet, energizing its coil which pulls down its armature and stem, thereby seating the lower magnet valve and unseating the upper magnet valve *161a.* Inshot air flows through choke *142,* past upper magnet valve *161a* through passages *17* and *17a* to diaphragm chamber *K,* thus balancing the inshot pressure on all diaphragms. With all lower magnet valves, *161, 161a,* and *161b,* closed, additional application pressure from passage *16a* can build up only in the diaphragm chamber *A* and act on the smallest diaphragm *60.* As the area of diaphragm *60* is 40 per cent of the main diaphragm, 40 per cent of the pressure in chamber *A* will be transmitted through the diaphragm stack to the main diaphragm. The application valve *32* and its piston *30,* therefore, will be held open by lever *43* until the brake cylinder pressure in chamber *F* and connected brake cylinders builds up to approximately 40 per cent of chamber *A* pressure, thus balancing the pressure on both faces of the main diaphragm, after which the springs *33* and *34* seat the appli-

cation piston *30* and valve *32*. This moves the upper end of lever *43* and piston *36* back to lap position in which the lower end of the lever holds the exhaust valve and its piston seated, retaining brake-cylinder pressure equivalent to 40 per cent of the straight-air-pipe pressure. This is maintained by the F. S. 1864 relay portion, as any leakage in brake-cylinder pressure will reduce chamber *F* pressure and cause the relay portion to operate and restore the balance of pressure on the main diaphragm. When train speeds exceed approximately 20 m.p.h., the speed governor deenergizes the L.S. magnet and spring *162a* seats the upper magnet valve *161a* and unseats lower magnet valve, permitting air from passage *16* to flow through passages *17* and *17a* to diaphragm chamber *K* where it builds up on diaphragm *64*. As this diaphragm is 60 per cent of the main diaphragm *38*, the brake cylinder pressure reproduced in cavity *F* by the relay portion is 60 per cent of that in chamber *K*. When train speed exceeds approximately 40 m.p.h. the speed governor energizes the M. S. magnet coil, pulling down its armature and stem which seats the upper magnet valve *161* and unseats the lower magnet valve, permitting air from passage *16* to flow through passages *18* and *18a* to diaphragm chamber N, where it builds up on diaphragm *68*. As this diaphragm area is 80 per cent of main diaphragm *38*, the pressure reproduced in connected brake cylinders and chamber *F* by the relay portion is 80 per cent of that in chamber *N*. When train speed exceeds approximately 65 m.p.h., the speed governor energizes the H. S. magnet coil, pulling down its armature and stem, which seats upper magnet valve *161b* and unseats lower magnet valve, permitting air from passage *16* to flow through passages *19* and *19a* to cavity *P* where it acts directly on main diaphragm *38*. The relay portion, therefore, reproduces brake-cylinder pressure equivalent to chamber *P* pressure. The operation of the diaphragm stack as controlled from the speed governor thus provides four braking ratios of 40, 60, 80 and 100 per cent which limit the maximum braking force.

152—*Q.—Explain the operation as the train speed reduces.* A.—As train speed reduces, the speed governor functions to reduce the brake-cylinder pressure in proportion to the reduction in train speed. As the speed drops below approximately 65 m.p.h., the speed governor de-energizes the H. S. magnet and spring *162b* seats lower magnet valve *161b*, cutting off the supply to diaphragm chamber *P*, and unseats the upper magnet valve. The air in diaphragm chamber *P* then flows through passages *19a* and *19*, past upper magnet valve *161b*, choke *138* and passage *15* to inshot chamber *C*, and through passage *15a* to exhaust valve *93*. The air in chamber *C* deflects diaphragm *85* against the tension of spring *88*, moving piston *84* to unseat exhaust valve *93*, opening passage *15a* to exhaust *Ex*. This exhausts the diaphragm chamber *P* to 7 lb. inshot pressure, after which spring *88* returns piston *84*, permitting the exhaust valve *93* to be closed by spring *94*. This leaves the medium speed M. S. magnet energized, which establishes the 80 per cent braking ratio on diaphragm *68*. The relay portion then operates to make a corresponding release of brake-cylinder air. As speed drops below approximately 40 m.p.h. the speed governor de-energizes the M. S. magnet, which causes the release of pressure from diaphragm chamber *N* through choke *140* and the inshot portion exhaust, thus establishing the 60 per cent ratio on diaphragm *64*. As the speed falls below 20 m.p.h. the speed governor energizes the L. S. magnet which causes the release of pressure from diaphragm chamber *K* through choke *142* and inshot portion exhaust. The chokes *138*, *140* and *142* control the rate of exhaust.

Self-Locating Stencils

Stenciling of the cars after painting is considerably facilitated at one large outdoor paint track by the use of stencil frames which can be applied to cars and which, at the time of application, are so located that the painter can proceed with his work without the use of guide lines or measurements. Two types of frames are in general use; the first, frames which are designed to hang from the top rail of open-top cars, the other, frames used on box cars and located in position from the side sill.



Three section stencil required on a gondola car

The side sill limits vertical position of stenciling—Supporting poles hinged to the frames hold the stencil firmly in place

Both types of frames are of lightweight wooden construction. The stencil material is a heavyweight cardboard. Frames for open-top cars are suspended by clamps over the top rail and the letters can readily be spaced for horizontal position by eye; vertical positioning is taken care of in the frames themselves. On box cars clamps under the side sill establish the vertical limit of application.

IN THE BACK SHOP AND ENGINEHOUSE

Truck for Handling Mounted Driving Wheels

A four-wheel rail truck has been developed for handling mounted driving wheels at the Southern Pacific general shops, Los Angeles, Calif., as shown in the illustration. It is the practice at this shop to mount tires on driving-wheel centers about 300 ft. distant from the overhead traveling cranes of the erecting shop. Before using the truck shown, it was necessary to roll the wheels this distance by hand on a flush track, about eight men being required owing to the heavy unbalanced counterweights opposite the crank pins. This method of wheel handling also involved some degree of hazard owing to the difficulty, and, in fact, practical impossibility of stopping the wheels exactly when and where desired once they started to roll.

To save labor and promote increased safety, therefore, the special truck, shown in the illustration, was designed and equipped with roller-bearing flange wheels so that the truck with a pair of mounted driving wheels in place can be readily pushed by one man on any standard gage material track throughout the shop. Referring to the illustration, the construction of this truck will be readily understood. It consists of a welded steel frame, comprising two 80-lb. side rails connected at either end by 3-in. angles and having a 1-in. by 4-in. steel bar welded in place in the center to stiffen the construction.

The end angles are welded to the rail bottoms and braced by short steel brackets, as shown at one corner. On the outside of the steel frame at each corner, a filler block and axle are welded to the rail and equipped with an 18-in. flanged cast-iron wheel, which revolves on 2½-in. roller bearings. The wheels of this truck are spaced 7 ft. on centers and the width set for operation on standard gage track. A sheet-metal guard, made of ¼-in. by 6-in. stock, is reinforced and neatly bracketed to the truck frame at each wheel position, as shown.

A 1½-in. pipe handle, 5 ft. 2 in. long, capped at each end, is supported in two handle bars made of ½-in. by 3-in. stock which is cut out and bent at the bottom so as to fit neatly between the head and base of the rail where it is welded securely in place. These convenient handles, one at either end of the truck permit readily pushing or pulling it in either direction.

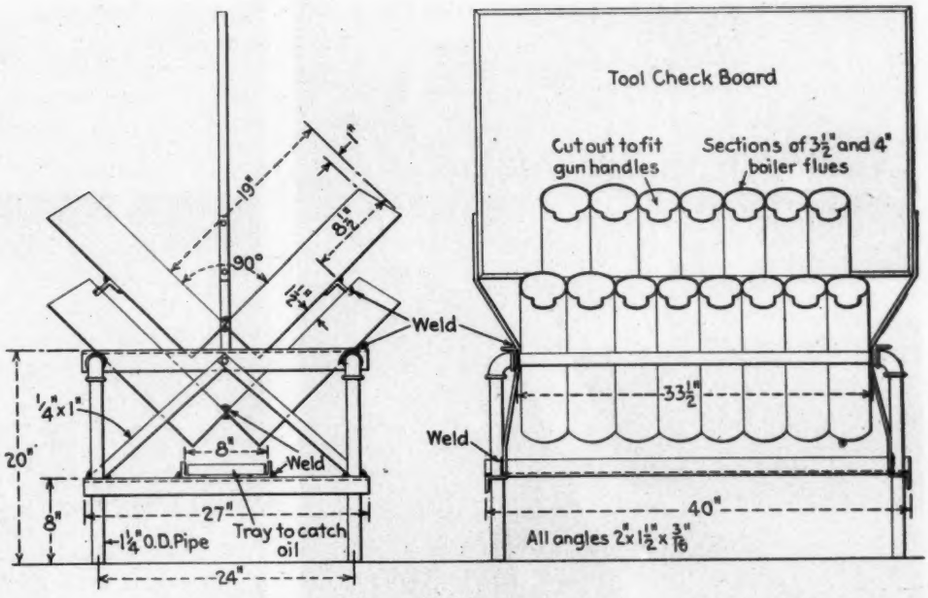
There is only one additional feature of this truck which might be mentioned, namely, the fact that, with the wheel-supporting rails spaced 4 ft. 1½ in. on centers, large driving wheels are carried satisfactorily, but smaller wheels would obviously drop lower into the truck frame and possibly have insufficient floor clearance. To meet this condition, four sliding steel shims 5 in. long by 2¾ in. wide on the top and 1½ in. thick are carried on the truck at all times and readily slipped in place under the driving wheel flanges when smaller wheels are being moved. The total length of this driving wheel handling truck over the handles is 11 ft.

Tool Room Rack For Holding Air Guns

The accompanying drawing and photograph show a convenient rack in use in a tool room for holding air guns. By the use of this device all of the guns are in an even row with the throttles in just the right position for oiling. The notches cut in the pieces of old flue make a place for the handle of the air gun to go, and

Truck used in handling mounted driving wheels at the Los Angeles shops of the Southern Pacific

Sufficient details and dimensions are given in this drawing to facilitate construction



The air-gun rack in use—The checks for the tools are shown on the board

make certain that they will remain in a uniform position. The air guns drain into the pieces of old flue, and from there into the removable drip pan or tray to catch the oil—no oil from the guns reaches the floor.

A board for holding the tool checks is right above the rack. Many steps are saved by keeping the tool and the check at the same location.

Two Lifting Devices From Topeka Shops

In the photographs are shown two special lifting harnesses for use in applying and removing and applying locomotive cross-compound air compressors and feedwater pumps. These were developed and are in use at the Topeka, Kan., shops of the Atchison, Topeka & Santa Fe. Both of these devices are secured to the equipment to be lifted by screwing trunion plugs into the intake- and exhaust-pipe hose. The air-compressor

A sling for handling feedwater pumps on and off the locomotive

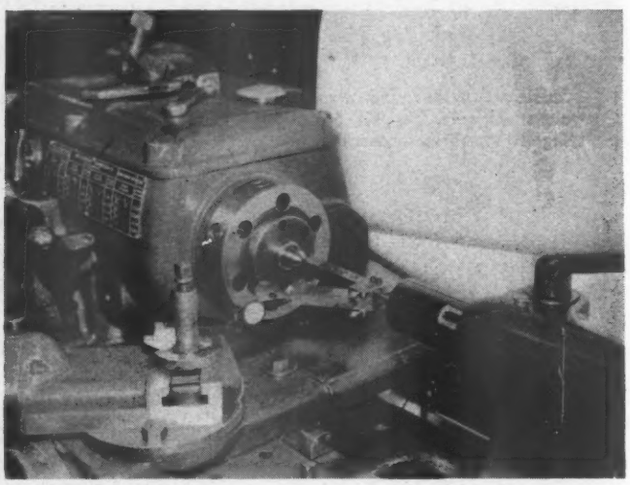
Harness for removing and installing locomotive air compressors which fits over the running board

harness is offset so that a compressor can be removed from the side of the boiler and replaced without removing the running board. It also protects the jacket and oil pipes from being damaged and insures safety in removing and applying the heavy compressors. By the use of this device one-half hour each is saved per operation. The harness for feedwater-heater pumps is, in effect, a part of a chain hoist. The horizontal brace rests against the cylinder heads of the pump, thus preventing it from swinging and holding it perpendicular. By the use of this device 24 min. are saved in the application or removal of the pump.

Tool for Angular Machining On A Lathe

A sine-bar arrangement for accurately setting a lathe compound rest at the desired angle without the use of graduations on the compound has been originated by G. F. Greene, a general foreman at General Electric's Schenectady Works. The tool was developed and is being used for the angular machining of high-precision bevel gears.

One leg of the bar is placed between lathe centers and the other leg is opened to the desired angle. The sine of the angle is obtained accurately by placing precision blocks between the fixed leg and the ground cylinder affixed to the movable leg. Two locking screws are provided to maintain the position after it is obtained. The compound rest is then set to the proper angle by the use of an indicator mounted to the tool post.



Method of setting the compound rest with the sine-bar attachment

Boring Chuck Retains Cylinder Roundness

*By C. T. Packer**

Difficulty is usually experienced in maintaining roundness in the finished bore as a result of holding methods in previous operations.

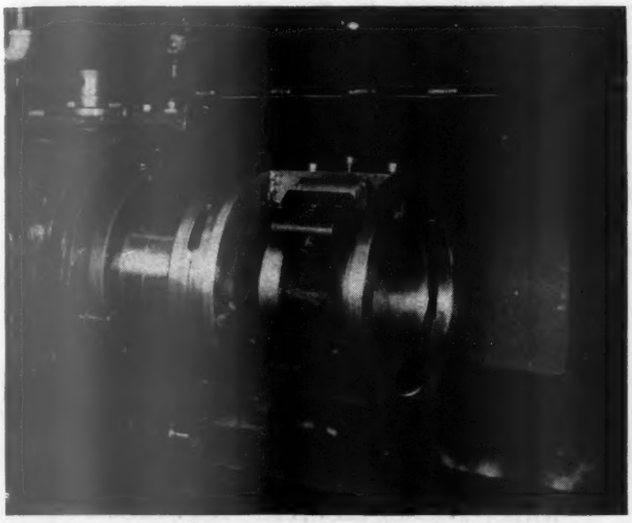
In a case where it is essential that the bore be round in a metal piece that is out of round on the outside, a chuck has been developed whereby three entering and support arms are bored the size of the finished diameter of the cylinder. Two of the supports are fixed, the other has release screws for easy loading and unloading.

In the face of the three supports is fitted a $\frac{1}{16}$ inch thick by 3 inches wide spring steel band having clamp lugs at each end. The groove for the band is $\frac{1}{32}$ inch deeper than the thickness which allows the band to lie in the clear for loading and unloading.

The cylinder is placed in the chuck. The band is clamped tightly around. Since the spring steel band is flexible it conforms to the contour of the cylinder but provides sufficient friction to drive the cut without distortion in the piece. After the clamp band has been tightened the clamp and cylinder unit is rotated until it stops against one of the supports which serves as a driver. The release screws are then tightened sufficient to hold the cylinder control but not enough to distort.

Satisfactory results are obtained from this type of chuck. For example, a cylinder 6 in. in diameter by 6 in. long to be turned outside and bored inside to 5.000 ± .001 in. The usual procedure is to start by using a three-jaw chuck. In most cases the chuck pressure nec-

* Westinghouse Electric and Manufacturing Company, Lima, Ohio.



This special chuck eliminates distortion when machining cylinders of a fixed diameter

essary to drive is sufficient to show a distortion of .005 or .006 in. on either bore or turn after removal from the chuck. By conventional methods of machining the distortion carries through to the finished product.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

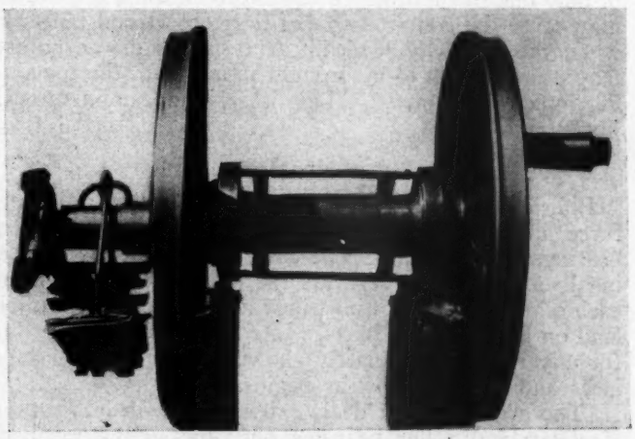
Setting Front Ends

Q.—We have trouble in setting front ends on a 40-ton Davenport, oil-burning locomotive. Can you give some information on front end setting and the drafting of the front end as to the firebox damper opening?—F. R. D.

A.—A typical smoke box arrangement for an oil-burning locomotive is illustrated. Dimensions should be great enough to give a clear area through the netting of 125 per cent of the total gas area when using netting having a clear area of 50 per cent or more. Increase *B* to give 125 per cent when using a netting having less than 50 per cent clear area as in coal-burning locomotives. Dimension *E* should be large enough to give a minimum of 100 per cent gas area under the table plate for outside steam pipes. Locate the table plate to compensate for the loss of gas area if inside steam pipes are used. However, the table plate should not be higher than the bottom of the lower flues on superheated engines. Dimension *H* is governed by the type of header used.

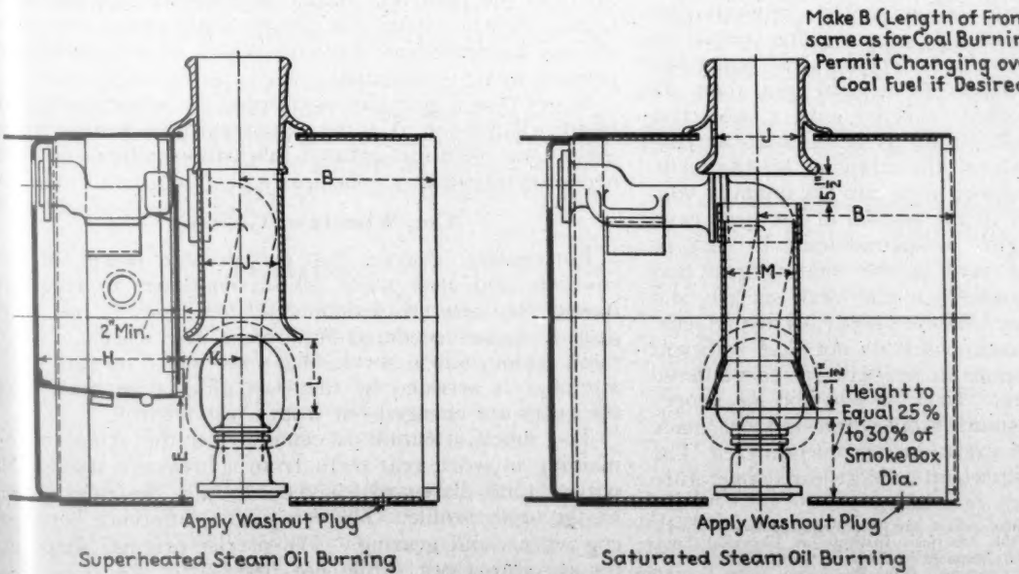
Spreaders to Hold Cup Rings In Place

The accompanying illustration shows a spreader to hold cup rings in place while counterbalancing roller bearing type driving wheels. Experience indicates that if the



The spreaders in use on the bearings on mounted wheels

bars of the spreader are tied together with strips welded in, it makes a solid job and there is no tendency for the assembly to collapse as the wheels roll on the balancing rails. Originally, four straight pieces of pipe were used.



	Standard Cast Iron Stack Extention		
M	L	K	J Dia.
9"	13"	11"	11"
10"	13"	12"	12"
11"	14"	12"	13"
12"	14"	13"	14"
13"	15"	13"	15"
14"	15"	14"	16"
15"	16"	14"	17"
16"	16"	15"	18"
17"	17"	15"	19"
18"	17"	16"	20"
	18"	16"	21"
	18"	17"	22"
	19"	17"	23"
	19"	18"	24"

Smoke box arrangements must provide sufficient clear area for proper drafting

ELECTRICAL LEADS

Traction Motors and Generators*

By J. W. Teker†

Some suggestions on the type of supervision required to prevent unnecessary shopping of Electric and Diesel-electric locomotives

SUPERVISORS confronted with the loss of expert workmen who carry routine practices in their heads or with the influx of new help must be especially on the alert for neglect of preventive maintenance methods and must again get close to the job to see that specific standing instructions are available and that schedules and records are not neglected.

The neglect of some simple detail by one man may start a chain of events to culminate in a serious breakdown and require an entire crew of men with shop facilities already sorely taxed to make corrections. The lack of only one-half minute's attention to cleaning a terminal may cause the contact surfaces to overheat and burn off when most heavily loaded. A resulting motor failure may cause a train to be brought in late with the remaining motors overheated. This is sabotage, unintentional but effective.

Lubrication

Lubrication of electrical traction equipment falls into three divisions, namely, sleeve bearings, anti-friction bearings, and gearing. The basic purpose of lubrication in all of these is to separate the moving elements from each other by a film of oil which must support the entire load on these moving parts. Interruption of this oil film for any reason immediately allows contact between surfaces and destructive wear begins.

[The original paper deals extensively with lubrication of sleeve and roller bearings but, due to the railroad man's familiarity with these requirements, this part of the paper is not included.—EDITOR'S NOTE.]

There is a common misconception that gear teeth are shaped so that they may roll on each other. Actually, the tooth surfaces slide on each other, the roll being confined to a very small portion of the profile, and the tremendous forces of moving a train are transmitted to the drivers through this sliding contact between gear teeth. It is a vital necessity to separate this contact by a lubricating film; otherwise, destructive wear is certain.

Gear lubricants in common use depend upon their adhesiveness to keep the teeth covered with a protective load-carrying film. This stickiness is essential as centrifugal force tends to throw the lubricant off the teeth. The lubricant is renewed as it dips into the quantity contained at a proper level in the bottom of the gear case. The properties of the gear compound must be such as to flow readily into the path of the rotating gear and yet be sticky enough to adhere to the tooth surface, and have load-carrying ability. These properties are affected by temperature. Most compounds do not have sufficient range to cover the extremes in temperature encountered from summer to winter. Careful selection of proper grades for winter and summer operation must be made where wide temperature variations are encountered. The heavy summer grade will set up solid at low temperature and the gear will channel through it without being wetted. A winter grade of thin lubricant during the heat of summer operation will fail to stick to the teeth at speed, or at heavy load is too thin to separate the gear teeth.

A few hours of heavy-load running without adequate lubricant may lead to irreparable damage. Gearing will overheat and damage the heat treatment of the steel. Excess pinion temperature by conduction through the armature shaft can overheat the roller bearing. The unequal expansion of inner and outer races, absorbing the internal bearing clearance until loaded beyond limits by internal radial stress, can cause complete destruction of the bearing, frame heads and even destruction of the armature core when it drops on the field pole pieces at high speed, all because of faulty gear lubrication.

A necessary adjunct to gear lubrication is the gear case or gear cover. Its two functions are to keep the lubricant in and to keep foreign material out. The tongue and groove joint between upper and lower halves, the baffles and seals around axle and pinion fit originally installed by the manufacturer are seldom maintained. This is so discouraging and futile that in some designs they are completely omitted.

Contamination of gear lubricant with material picked up from the road bed makes an excellent lapping compound with no chance for grit to settle out in the thick viscous lubricant and the very object of lubrication, to prevent wear, is defeated.

Every time a gear case is dropped for wheel change or motor change-out it is an opportunity to renew seals, check gear teeth for signs of lubrication failure and take necessary preventive measures.

Cog Wheels or Gearing?

Fortunately, gearing has considerable power of recovering and after many abuses continues to transmit power even after its fundamental tooth profile has been destroyed and rendered into mere cog wheels. Gear teeth seldom fail in service but continue to operate until attention is arrested by their appalling appearance and the gears are changed out from sheer fright.

Too much attention is centered on the strength remaining in worn gear teeth from a breakage standpoint with a total disregard for the carefully designed shape of the tooth profile. There is a vast difference between cog wheels and gearing. The precise original shape of the involute tooth, while not necessarily the only pos-

* Abstract of a paper presented under the title "Keep Them Rolling," before the annual meeting of the American Institute of Electrical Engineers held in New York, N. Y., January 26, 1943.

† Engineer, General Electric Company, Erie, Pa.

sible shape, is to maintain uniform angular velocity between gear and pinion. Deviation from a proper shape for uniform angular motion for any reason makes smooth uniform rotation between pinion and gear impossible and jerky power transmission begins, attended by severe instantaneous stresses and torsional vibration.

When gear, pinion and axle linings remain mated over a long period the wear is gradually adjusted between the members without causing serious deviation from normal operation. This may continue until bearing lining wear effects a gradual increase in gear center distance and the gearing may also wear to a depth sufficient to produce a step in each tooth profile.

Now, if the gear center distance is restored by installing new linings it is evident that the tooth tip will be caused alternately to ride up and off the step formerly worn into each tooth and there is interference. The same occurs when a worn gear or pinion is mated with a new one. Tremendous stresses are set up at the interference point until the teeth are battered into agreement. While this is going on the armature shaft, bearings and the armature winding are enduring the punishment of bending and vibratory torsional stresses.

The interdependence between apparently unrelated parts is startling; lubrication failure in gearing or axle linings may be followed by broken armature shaft or a grounded armature winding resulting from vibratory stresses beyond the limits of the construction during the breaking in period of unrelated gearing.

As soon as operators recognize the characteristics of true gearing they will give immediate consideration to such practice as keeping gear and pinion mated even though the motors themselves are changed around. When a motor is changed out the pinion is removed and installed on the in-going motor, thereby keeping the same pinion and gear running together. In order to retain existing gear center distance, the linings should also be removed and installed on the ingoing motor.

When worn gearing must be matched with new or where interference in tooth profile may result for any reason, consideration should be given to having the worn gearing replaced immediately with the same dispatch that worn wheels are ruled off the road. Fundamentally the question resolves itself into a choice between the additional miles to be obtained from damaged gearing and the punishment being sustained by a costly traction motor transmitting its power through cog wheels no longer capable of their original gearing function. Where armature failures are frequent this aspect of the problem is worthy of serious study in the interests of economy and availability.

Present day facilities for pulling pinions, easily controlled means for heating pinions, and the measurement of correct advance simplify the pinion mounting operation to such extent that the practice of keeping pinions and gears mated is simple, quick and attractive in view of the benefit to be gained.

Insulation

There is much that can be done to forestall trouble in motors and generators while they are mounted in the locomotive. A regular check of insulation resistance with a Megger when a locomotive comes in from a run is a simple and quick operation, yet it may detect a defect which might result in a ground failure on the very next run.

Make high potential tests sparingly and carefully, preceding them with a Megger insulation check; otherwise a puncture or creepage failure may result from the test which could have been avoided by first finding the weak spot with the Megger and cleaning, drying or repairing locally as necessary.

Brushes and Brush Rigging

Care must be exercised when installing new brushes to prevent the snapping down of spring levers with such force as to chip or shatter the brush. Carelessness in this respect may ruin a brush before it has a chance to render useful service.

Install a new brush in such a manner that the pigtail is placed on the far side of the carbonway away from the side on which the pigtail terminal screw is located. This permits an easy loop to be made over the brush, with little chance of its being bent over the edge of the carbonway and thus hang a brush up so as to prevent free vertical movement. Where pigtails bear against the edge of the carbonways or spring levers, there is a rapid wear of the individual strands by prolonged vibration until the pigtail is cut through and left free to wave about, with possibilities for motor flashover or ground.

Dusty operating conditions allow granules of dirt to collect between brush and brushholder carbonway which results in causing the brush to stick so that the freedom of vertical motion is restricted and the brush does not ride the commutator properly. This contributes to sparking, flashovers, rapid commutator and brush wear. These granules leave unmistakable evidence in the side walls of the brush in the form of lightning shaped, threadlike grooves, radiating from the top to the bottom of the brush where it makes contact with the carbonway. The correction is to find where and how grit enters the equipment and then take preventive measures if possible, and to frequently slide the brushes in the holders and blow the clearance space clear of dirt.

The screw which secures the spring lever shunt to brushholder body is worthy of careful inspection, being hard to get at and commonly overlooked, yet capable of serious damage to the motor. When this screw works loose and causes poor contact between the spring lever shunt and the brushholder body, the current normally carried by the shunt is caused to flow through the brushholder spring instead. Under heavy load, this current may be of sufficient magnitude to anneal the spring and cause loss of spring tension on the brush. The failure of the brush to maintain contact with the commutator causes arcing and overloading of other brushes, which ultimately leads to flashovers or complete destruction of the brushholder by melting off from sustained arcing. The possibility for this screw to work loose completely and fall onto the commutator where it jams against a brushholder and causes a deep groove to be cut into the commutator, short-circuiting all segments, is more serious, making it necessary to cut the motor out of service and remove it for major repairs.

Commutators Reveal History of Locomotive Handling

Observation of commutator surface appearance is a quick means for sizing up the general health of the equipment. Poor appearance is evidence to the practiced eye that trouble exists, but it is not always so simple to quickly ascertain the true cause. Fortunately commutators are capable of long suffering and like gearing they seldom fail suddenly, but give ample warning of impending trouble in time to hunt down the cause. Poor commutator condition does not always imply that the cause is within the machine, but may also be traceable to external faults or conditions, the effects of which reveal themselves on the commutator and leave their record burned into its surface.

For instance, it is not uncommon for enginemen trained in steam practice to completely stall the locomotive intentionally or forgetfully for unduly long periods with partial power on the motors. This is harmless in steam and even good practice under some circumstances, but is capable of extreme damage to the electric drive. This may occur when a train is braked to a stop with power on to keep the train slack stretched out for a smooth start and then failing to shut off power for the duration of the stop. Again, a train may be held on an inclined spur with power on while the train crew look for blocks to hold a car so that it can be uncoupled from the train.

Fundamentally, any operation which brings a motor to standstill while heavy current continues to flow causes intense local heating at the point of contact between brushes and commutator, especially if brushes are tipped to contact along one edge of their face by a slight backward movement of the armature just before the full stop was made. These local contact spots when unduly prolonged may reach red or white heat and anneal the copper commutator segment involved, and also burn the shellac binder in the mica segment or mica commutator cone.

This local damage, varying from one overheated bar to as many as four groups of bars spaced 90 deg. apart in severe cases, does not immediately incapacitate a motor. The overheated segment now annealed, or the burned mica, lacks the necessary strength to keep its position under the action of centrifugal force at high operating speed and creeps above the general commutator bar surface to become a high bar with the attendant marking and burning of the surface, or the shattering of brushes and frequent flashovers.

Such bars may be found near or in the telltale burned spots at equally spaced intervals 90 or 180 deg. apart and it may be evident by the discoloration at their ends, marking them from the others, or they may require searching for with a scleroscope or some equivalent means.

While it is possible to keep such motors in operation by frequent cleaning or stoning of the commutator surface, ultimately a major repair is necessary to remove the annealed bars, patch or renew mica cones and reassemble with new hard bars.

A closer regular pattern of burned bars, especially in generators, traceable to external causes, may be brought about by the engineman failing to make a backward transfer to the series connection upon encountering a grade with a heavy train such that the speed is dragged down and the current of motors in parallel connection exceeds the commutation ability of the generator, and when prolonged, burns the commutator and overheats the armature winding.

A similar commutator condition is also possible by the accumulative flashing at brushes over a period of time, brought about by a delayed transition from series to parallel motor connections, in which case the control equipment requires attention and adjustment.

Sluggish reverser operation during extremely cold weather when air compressor oil condensate may reach reverser air cylinders can cause severe shock to the entire transmission apparatus by allowing Diesel engine speed to rise well above idling speed before the circuit is closed through the reverser contacts.

Sluggish air brakes may lead to emergency or convenient plugging of motors into reverse while the train is still moving ahead to effect a quick stop. The magnitude of the commutation task under such conditions is bound to blast the commutator surface, leaving a wake of splattered copper beads and craters in the surface to upset the smooth riding of the brushes.

Resurfacing Commutators During Layover Time

There are occasions, whatever may be the cause, when locomotive commutators require resurfacing in order to continue operation. Much of this can be quickly and easily accomplished in the locomotive unless the condition is such as to justify removal to a repair shop.

Such resurfacing is commonly done with a commutator resurfacing stone held by hand or in a tool and applied to the commutator, rotating at sufficient speed to do a good grinding job. When the stone is hand held it should be large enough to permit a maximum arc of contact with the surface. This will allow it to ride over the low spots, rather than down into these hollows, and thus cut the high spots down first and thereby tend to produce a cylindrical surface. Remove a brushholder when it prevents the use of an ample stone size.

When irregularities are beyond correction with a hand stone, a rigid tool or fixture can be adapted to the special needs of the machine to hold the cutting stone steady or to mount a conventional carboloy-tipped lathe cutting tool for the rough cut and then finish with a stone.

The brushes should be removed during the resurfacing operation to prevent their rapid wear and dusting. Clean the oily and greasy surfaces before proceeding with the resurfacing so as to prevent adherence of the grinding dust and to permit easy cleaning of the equipment after finishing with the operation. When possible, erect cardboard shields so as to baffle the interior of the machine against entrance of this dust.

Install two old brushes to supply power for driving the motor armature during the stoning. The axle, mounting the motor, is then by suitable means jacked up so that the armature and wheels are free to rotate. The remaining wheels of the locomotive must be blocked or have the brakes set so as to safely hold the locomotive stationary while the one axle is raised and left free to rotate.

Driving power may be simply obtained from the locomotive's own Diesel power plant by going into the first operating position which, in most cases, will provide sufficient speed to do an excellent resurfacing job. The current required to rotate the armature is so low that no damage will result to the stationary motors through which this same current is flowing. An alternative, if preferred, is to obtain power from a welding set or some other suitable direct current power source.

In the case of a generator a similar resurfacing operation is possible in the locomotive by first starting and warming up the Diesel engine so as to permit a quick easy start later, then shut down and remove most of the brushes from the commutator, leaving only a few easy-to-reach brushes in about three-quarters of the readily accessible brushholders of each polarity.

The engine is again started and these remaining brushes are removed and the resurfacing operation is ready to proceed without affecting the brushes, which, as in the case of the motors, would be excessively worn during a prolonged resurfacing operation. Block out all contactors to insure no-voltage during the process.

The "Air Cure"

Thorough cleaning of the apparatus is essential and special attention must be given to the undercut spaces between segments to see that all dragged over copper, accumulated dirt and carbon are removed.

A powerful tool for the detection and cleaning of these spaces is a procedure referred to as "air curing."

A strong jet of dry compressed air is blown against the commutator, held close to and directed across the surface so that the impact will dislodge material in the grooves while the commutator is rotated at gradually increasing speed and maximum no load voltage.

In the case of a generator, this is done with motor contactors blocked out to open the load circuit and field contactors closed in to obtain maximum excitation at full engine speed.

In the case of a motor, this is done at available voltage within the speed limitation of the motor, which for practical purposes is sufficient. It is possible, when necessary, to obtain full motor voltage at full speed by resorting to separately controlled motor field excitation circuit in order to keep within the maximum motor speed limitation.

When sparking or rings of fire appear under the impact of the air jet, the speed and voltage should be held until it clears up. It may, in stubborn cases, be necessary to shut down and dig the troublesome spots clean before proceeding.

It is well to apply this air cure process to motors or generators reported to repeatedly flash over for unknown and unfound causes as a means to locate weak spots in commutator segment insulation.

The operator should protect himself during resurfacing and air cure processing against flying particles, dust and flashover by wearing goggles, respirator and suitable gloves in keeping with approved safety practice.

Cables, Cleats and Connections

Motor cables and cleats should be examined each trip as the swing of cables between locomotive and motor concentrate stress at the cable cleats which becomes the point of wear and cracks in insulation. Such defects, if not discovered and repaired, will lead to motor or power plant failure, especially during wet weather when creepage over and through these broken surfaces will result in a ground which may be serious enough to burn off a motor cable.

Motors are at times removed in emergencies and during the rush the contact surfaces of the terminals may be overlooked so as to make contact through a dirty surface which, later in operation, will cause overheating and the melting of the soldered connections between terminal and motor cable, which may become serious enough to burn the connection off completely, open circuit or ground the equipment.

Loose Bands Can Lose Armatures

The loss of a power plant may overload the remaining equipment in order to bring the train in. Operators may take pride in bringing a train in under such conditions and justly so, but the maintenance man must be on the alert to see what the consequences of such operation are to the remaining equipment. Enough damage may result when heavily overloaded to cause loosening of bands, shrinking of insulation, and slot wedges which permit the vibration of armature windings. The mechanical vibration of conductors ultimately wears insulation thin so that final failure occurs by electrical breakdown when least expected and under comparatively easy operating conditions. Such failures result from former abuse.

Similar damage from overheating is caused by operation without traction motor blowers when necessary for adequate ventilation of the motors, or insufficient air when fan belts slip.

Overloaded motors should be changed out as soon as possible without waiting for the completion of their standard reconditioning mileage. Remove the armature immediately to make a careful inspection of bands, wedges and insulation.

Extreme temperature gradient will exist within the motor during overload operation. In parallel ventilated traction motors the armature temperature may be expected to increase from the commutator end to the pinion end. The end winding will be hottest because it is insulated and covered over by a band and is ventilated by the hottest air, while the commutator end of the winding can conduct its heat to the exposed surface of the commutator. Where overloads persist as on a grade or are repetitive, such as frequent starting of a train with one of two power plants shut down, pinion end temperature may easily reach a value sufficient to melt the solder on the pinion end band and yet leave the commutator end band and commutator rise soldering intact.

Such damage may easily escape detection by casual observation through the commutator end inspection opening. Hence the importance of disassembling to be able to view, tap and feel the pinion end band for signs of loosening.

A band unsoldered, especially at speed, will cause its relaxation and this along with shrinkage of varnish and insulation at these extreme temperatures permits vibratory movement of the windings. Prolonged operation with such mechanical motion wears through the insulation and culminates in ultimate electrical failure.

This mechanical condition detected in time has good prospects of successful repair if the band and band insulation are removed and the armature winding is thoroughly treated in good insulation varnish and again rebound. This treatment is comparatively quick and inexpensive as compared with a serious failure due to neglect, necessitating a complete rewind in order to restore it to service. The prospect of successful operation, after delayed treatment, is difficult to predict. Slot wedges should also be checked and renewed when damaged as these may allow the winding to burst out of the slots even though the end bands are renewed.

This is a good time to emphasize the importance of proper anchoring of the ends of the banding wire. The anchor should be such that it will hold even after the solder is thrown off. It will permit operation so as to bring the train in, which otherwise may have resulted in losing a band and bursting the winding.

There are various designs for anchoring of the band, the basis of which is to have the start and finish of the band caught in the same clip extending through from one side of the band to the other. The ends of the band are looped back and then secured by pulling the end of the clip back under the turns adjacent to the end. A band so secured may slip and relax slightly when unsoldered but will not let go.

When overloads are sustained so that all parts of the armature tend to reach uniformly high temperature, all bands will unsolder as well as the commutator riser connections and this is easily detected by observation through the commutator end inspection opening. Operators are quick to remove such obviously damaged motors, but unfortunately, where outright failure has not occurred, the tendency is to assume that all is in order and continue operation while under the surface of the relaxed armature band the vibrating winding is eating into the vitals of the armature.

Failures do not happen—they are caused, and deserve close engineering inspection and analysis with unprejudiced zeal to search the events leading up to the failure before corrective measures in design, operation or maintenance can be intelligently and effectively applied.

DOODLING "DOOD IT"

Just as the conductor came in for tickets, Sparks stopped doodling and eyed one of the figures he had absent-mindedly drawn

By Walt Wyre

"THE division engineer wants to know when you can go to Sanford and install the wiring for the automatic equipment on the boiler," H. H. Carter, master mechanic of the Plains division of the S. P. & W., said to Ned Sparks one morning a few days before Christmas.

"Well," the electrician hesitated a moment, "I've got quite a bit of work here that should be done. They're in a rush to get the wiring done for the main-line fuel-oil cranes. The new well they're putting in will be ready for the pump motor next week and everybody is hollering about getting push-button stations for the cold-water pump in the washout plant."

"Have you got the material for all of those jobs?" the master mechanic asked.

"Everything except for the push-button stations," Sparks replied.

"Well, I guess you had better stay and finish some of the work here in Plainville," Carter said. "Those main-

line oil cranes will save considerable time running engines through and if we don't get that new well going pretty soon, water will have to be rationed. The city has already notified us that they will not be in position to sell us water much longer. I'll tell the division engineer it'll be after the first of the year before you can do the job at Sanford."

The master mechanic went back to his office. The electrician went to the storeroom where he had started when the master mechanic had stopped him.

Dick Wheeler, the car foreman, was in the storeroom when Sparks got there. "Say, when are you going to get a push button at the car department for the water-pump motor?" Wheeler asked.

Sparks felt in his pockets as though looking for something and shook his head. "Haven't got it," he said seriously.

"Haven't got what?" Wheeler inquired.

"Haven't got 3,000 feet of weatherproof wire, eight three-wire racks, and a few other odds and ends needed to put a push button at the car department for the water pump."

The car foreman didn't seem to appreciate Sparks' attempt at humor. "I've been trying to get a push button for that pump over three months. Every time we wash out a car I've got to send a man to start the pump, then send him back to stop it, or else leave the pump running. I haven't got enough men to do the work as it is without having one putting in half his time walking back and forth to start and stop that pump."

"That's right, I guess," Sparks agreed. "And the roundhouse foreman doesn't like to have to send some one when he fills a tank in the house, but I can't do the job without material and it'll take somebody with more power than I've got to get it."

"Well, I'm going to talk to the master mechanic about it," Wheeler said.

"Ask him to get a couple of pounds of bacon and some coffee," Sparks said, but not loud enough for the car foreman to hear. Wheeler was usually ready to joke, but he didn't seem to be in exactly the mood at the moment.

"How about a few half-inch conduit straps?" Sparks asked the storeroom clerk who had come up while Sparks and the car foreman were talking.

"How many?" the clerk asked.

"Two dozen; how many do you have?" Sparks replied.

"None," the clerk answered.

"Anyway, you have a good alibi that'll last for the duration," Sparks said. "But I'm not disappointed, I already had a sheet of second-hand galvanized car roofing spotted to make some straps before I came to the storeroom."

SPARKS and his helper would have finished the job of wiring the main line oil cranes in four or five days if the work had not been interrupted by various other emergency jobs that became more frequent as the approach of Christmas brought the crest of the flood of business that already almost had the S. P. & W. submerged.

The wiring was finished December 22. The day water-service men started installing the pump in the new well. Sparks had it all figured out—he and his helper would run the three-span line in the next two days, then he and his hireless cooker would do a little celebrating Christmas Eve, then set the alarm clock as usual so he could have the pleasure of telling it to go to hell next morning, then sleep until noon.

That was the afternoon the portable crane hook caught on the conduit that carried the welder circuit in the roundhouse. A new man was operating the crane, he was backing up and watching to see that he didn't hit anything with the crane. He didn't notice that the boom was too high to clear the conduit. How he managed to catch the conduit will always remain a mystery, but he did. Then instead of stopping when the crane stalled he shoved the lever down and gave it all the power it had.

Sparks went to the roundhouse office and phoned his wife that his part of the celebration would take place in the roundhouse. While the electrician was getting a couple of wrong numbers, the roundhouse foreman came in and handed Sparks the last straw, except it wasn't a straw but a piece of yellow paper.

Sparks finished reading the typed message while waiting for his wife to answer the phone. She placed the receiver to her ear just in time to hear Sparks say "I'll be damned."

"You must have the wrong number," Mrs. Sparks said.

"Oh, hello, no, I wasn't talking to you. I'll be a little late getting home. . . . No, I wasn't swearing at you, I was swearing at this message. I've got to work tomorrow, got to get the motor on a pump connected. Sorry, I can't go with you. . . . No, you needn't wait for me, it'll probably be ten or eleven o'clock before I get home—'bye!" Sparks hung up the receiver and went back to the roundhouse.

It would have been quicker to run new conduit where the portable crane had broken the line, but there wasn't any new available. The 1¼-in. conduit had broken off at a coupling but did a lot of bending before it broke. The wires carrying current at 440 volts were shorted and burned through before the fuses went out which made it necessary to pull in new wire.

However, Sparks had been slightly pessimistic about the time it would take to finish. He had it done by 9:30 which was still too late to eat, clean up, change clothes and go places and work next day.

CHRISTMAS day was neither white, bright, nor merry for Ned Sparks and his helper. A cold raw wind from the northwest reminded the electrician of a perfectly good sheepskin lined coat that his wife had given during a "bundles-for-Britain" drive. There weren't any more when he tried to buy another.

Despite the cold Sparks and his helper made fair progress on the job. They didn't finish, but all they lacked was soldering and taping connections and connecting the controller wiring.

Next morning while they were finishing the wiring to the pump motor the master mechanic came out.

"How are you getting along?" Carter asked.

"Oh, fairly well, I guess," Sparks told him. "We should have it ready to try out in about an hour."

"That's fine," the master mechanic said.

Sparks knew by experience that when the master mechanic used that "well done" tone of voice he had something else up his sleeve or to be more exact, in his mind. This time was no exception.

"Can't you manage to dig up enough material to install a push button at the car department for the cold-water pump motor?" Carter asked.

"Well," Sparks spoke dubiously, "I doubt it. Material has been ordered but I don't know when we'll get it."

"It sure is needed; takes a lot of time for a man to walk all the way from the car department to start

the pump then walk back to the washout plant to stop it. See if you can't figure out something on it." Carter stood around a few minutes looking at the pump and asking an occasional question, then went to the roundhouse. "Let me know what you figure out on the push button," he said as he left.

Sparks finished connecting the well-pump motor, started the motor and let it run just enough to see if rotation was in the right direction. It was, for a wonder; then he and his helper gathered up his tools and carried them to the electric shop. He then started, without hope of success, hunting wire to run a control line for a push-button station at the car department. He spent the time until noon searching for material. The net result was almost five or six hundred feet of odds and ends of wire of assorted kinds and lengths. In one corner of the treating plant where material left from jobs was sometimes thrown Sparks found a mercury-tube pressure switch. He looked at it a moment, noticed that the range was from 10 to 100 pounds, then laid it down.

AFTER lunch Sparks went to the washout plant, stood around several minutes looking at everything in general and nothing in particular. Buzzing around in the back of his head like a bumble bee in a jug was an idea that the mercury pressure switch might somehow be used to start the motor when a valve was opened at the car department and stop it when the valve was closed.

He figured out a way to stop it if the pump was running. When all valves were closed, increased pressure would operate the pressure switch and stop the motor but that was only half the problem—besides getting the cart before the horse. The pump had to be started before there would be any need of stopping it. Still, that was something. It would save half the trips from the car department to the pump.

Sparks went to the treating plant and got the pressure switch and carried it to the electric shop. He was sitting on the work bench looking at the pressure switch when the master mechanic came in.

"Well, how did you make out finding material?" Carter asked.

"Not so good," Sparks replied, then told him about the idea for stopping the motor.

"What's going to happen if somebody goes and starts the pump without first opening a valve?" the master mechanic wanted to know.

"The pressure switch would stop the motor," Sparks admitted. "I never thought of that," he added.

"Well, maybe you're on the right track, anyway," the master mechanic said. "Keep working on it."

"I'm just a plain garden variety of damn fool!" Sparks told himself when Carter had left. "Why didn't I just tell him that I couldn't get the job done until I got the material and let it go at that!"

Except for a little time on a few small jobs, Sparks spent the afternoon until quitting time figuring on the problem without success. Several times he decided to give up and quit thinking about it, but his mind wouldn't let him. That night after he went to bed he lay awake almost an hour thinking about it. Either before or after he went to sleep, he never knew which, an idea entered his mind and was there when he awoke next morning.

Right after eight o'clock Sparks headed for the car department.

"Want me to go with you?" his helper asked.

"No," Sparks replied, "clean up the shop while I'm gone."

When Sparks reached the car department he opened a valve in the line from the cold-water pump. Water flowed in a full stream from the one-inch pipe but with little pressure.

"Going to get the push-button in?" the car foreman came over and asked.

"No, I'm afraid not," Sparks told him. "I was figuring on a flow switch, but I'm afraid there isn't enough pressure to operate one."

WHEN Sparks passed the master mechanic's office on the way back from the car department, the clerk came out and stopped him. "There's a wire from Sanford says the automatic boiler control is out of order. They want you to go on the Limited at 9:30 and fix it."

"I didn't know the automatic controls were installed on the boiler at Sanford," Sparks said.

"I don't know anything about it," the clerk said. "All I know is this wire came a few minutes ago."

"O. K." Sparks didn't wait to argue, but headed for the electric shop and started gathering up tools.

He arrived in Sanford about noon, rushed over to a restaurant and ordered a cup of coffee and a meal to go with it. That disposed of, he went to the boiler room.

"Water-service men did the wiring," the fireman in the boiler room explained. "They were in a rush and said the electricians couldn't get to it."

"Who told them how?" Sparks wanted to know.

"Some expert from the company that sold the equipment," the stationary fireman said.

"Well," Sparks remarked, "the man that told them how may be an expert in his line, but evidently is a little out of practice in wiring. I would like to know how they pulled five No. 14 wires through half-inch conduit with those short kinks in it."

"They put the wires in the pipe then bent it," the fireman explained.

Sparks walked around looking at the equipment. Except for the job of wiring, it appeared to be an excellent outfit. The electrician studied a blueprint fastened inside the cabinet door and found that while apparently complicated, operation was really comparatively simple. Starting with the fire out, operation was, he found, as follows: Pressure-switch contacts closed when the steam pressure dropped to a predetermined point. The pressure-switch contacts closed a relay circuit that turned on gas for the pilot light and started the oil-burner motor. An electric eye operating from the pilot flame caused a relay to close which opened the fuel-oil valve; shortly thereafter a delay switch caused the gas to the pilot flame to go out. A three-electrode water-level control regulated the supply of water to the boiler and shut off the fire if the water became too low.

Sparks tested the wiring and found it to be grounded in the conduit. He removed a Condulet cover and found it full of water which explained the ground.

"How in thunder did all of this water get in the conduit?" Sparks asked.

"Don't know," the fireman replied, "unless it got in there yesterday when they washed the boiler."

Sparks then began to examine the wiring more closely. He found everything grounded except the three-phase line to the feedwater pump motor. He also found a piece of conduit running just over the fire door nearly red hot. Insulation on the wires in that particular piece of conduit was charred so that a little rubbing would reduce the rubber to powder.

"How soon will you get it fixed?" the fireman asked.

"You can still fire by hand, can't you?" Sparks asked.

"I'm firing by hand now."

"O. K., you'll probably have to keep firing by hand for the next week or ten days. I've got to pull all of this wire out and do the whole job over and do it right."

"It won't take ten days to do the wiring, will it?"

"No," Sparks told him, "but I've got to have some material. I hope there's enough for the job at Plainville. If there's not, no telling how long it'll be."

The electrician started in disconnecting wires and pulling them out of the conduit, or rather trying to pull the wires out because most of them wouldn't come. After breaking several wires he gave up and started cutting the conduit with a hack-saw.

Sparks worked until five o'clock removing the conduit and wiring, then made a list of material required to replace it properly. He just had time to clean up, eat and catch the Limited back to Plainville at 6:45.

SEATS were scarce on the train, but Sparks found a vacant spot in a smoker. After he had filled out a pass slip, he took out his notebook and checked the various items of material that would be needed at Sanford, then his subconscious mind which scientists say never sleeps called attention to the fact that the problem of starting and stopping the cold-water pump motor at Plainville was still unsolved.

Not having any definite idea in mind, Sparks began "doodling." Evidently the subconscious mind has some control over even such unpremeditated actions as drawing apparently haphazard designs, because Sparks' "doodling" followed a fairly definite pattern consisting mostly of square or rectangular boxes with and without lids.

Just as the conductor came in for tickets, Sparks stopped doodling and eyed one of the figures he had absent-mindedly drawn. "I believe I've got it!" he spoke aloud.

"You mean your pass?" the conductor inquired.

"No—yes—here's a pass slip." Sparks fumbled and started to hand the conductor the notebook. "I was thinking about something else," he explained a little sheepishly.

Next morning Sparks went to the boiler foreman and told him that he would like to have a box made of quarter-inch boiler steel with a half-inch flange and cover to fit one side, the box to be four inches square and eight inches long.

"What's it for?" the boiler foreman wanted to know.

"I'll tell you later," Sparks promised, "if it works."

When the box was finished, Sparks cut a piece of 1/16-in. steel that fitted loosely crosswise in the box. Then he secured two old valve bonnets. When the thing was finished he had a flow switch that he hoped would work. By making the flow switch square instead of round, the paddle could be fashioned to close the opening almost entirely and thus a very slight flow of water would cause the paddle to move. The valve bonnets were used for packing glands for the rod to which the paddle was fastened. A lever arrangement on one end of the rod actuated a mercury tube switch, taken from the pressure switch, thus making contact.

Sparks finished the switch, then persuaded a water-service man to weld pipe connections on each end and connect it in the cold-water pump discharge line. He connected wires from the motor controller to the mercury switch, then went to the car department and turned on the water. He waited a minute that seemed ten—the water flowed sluggishly from the pipe—a half minute more and the same thing. He started to close the valve and admit he was wrong when suddenly the water came with a force that almost jerked the hose from his hand.

He closed the valve and waited four or five minutes to make certain the paddle of the flow switch had time to get back to off position and tried it again. The motor had shut off and it took about the same length of time as before for the motor to start again when the valve was opened.

Sparks tried the flow switch several times, then satisfied it was O. K., went to the master mechanic's office.

"What did you find at Sanford?" the master mechanic asked.

Sparks explained about the wiring and told him the job would have to be done over.

"They would have been ahead by waiting," Carter remarked. "Have you figured any more on a push-button station for the cold water pump?"

"No, sir," Sparks admitted.

"Why haven't you?" Carter raised his voice slightly so that only the lower panes of the windows rattled.

Sparks grinned. "I couldn't get material for the control line, but I don't believe we'll need it." He explained about the flow switch.

"If it works you can have New Year's day off," Carter growled.

Sparks and his wife celebrated Christmas by staying out until midnight New Year's eve and sleeping late New Year's day. Next day after his late Christmas, he went to Sanford and rewired the boiler controls.

* * *

A New Haven passenger train, hauled by a two-unit Alco-General Electric 4,000-hp. Diesel-electric locomotive

NEW DEVICES

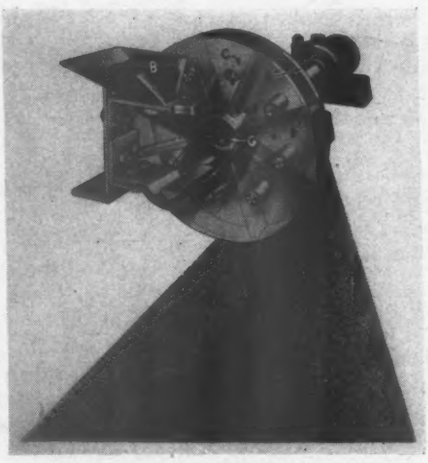
Cleaner for Boiler Tubes and Flues

A mechanical unit for abrasive blast cleaning in removing scale from locomotive boiler tubes and flues has been introduced to the railroad shops by Joseph T. Ryerson & Son, Inc. Known as the Ryerson American Wheelabrator flue cleaner, the machine built by the American Foundry Equipment Company, Mishawaka, Ind., utilizes many of the features developed by that company for use in regular foundry practice in the cleaning of castings.

The Wheelabrator is a simple mechanical unit that utilizes controlled centrifugal force instead of compressed air for abrasive blasting. Designed for use with mechanically handled boiler tubes, rotating flues are carried through the machine one at a time. In the Wheelabrator process abrasive from an overhead storage hopper is fed to the center of a wheel, whereupon it is hurled under control upon the work to be blasted.

The cabinet in which the Wheelabrator is housed is built up of heavy steel plate, reinforced by angles welded in place. At points where abrasive action is greatest replaceable wear plates are provided. Tubes or flues enter and leave the cabinet through small vestibules in which a series of baffle curtains prevent the escape of the abrasives used.

The blast unit, simple in design, utilizes controlled centrifugal force for abrasive blasting and is mounted at the top of the cleaning cabinet in direct line with the travel of the work piece. The plan view shown indicates the operating characteristics of the Wheelabrator unit. Metallic shot or grit, or a mixture of the two, is fed into the funnel (*A*) from a storage hopper. A cast-alloy impeller (*G*) rotates with the motor-driven wheel at high speed and forces the shot or grit through an opening in the stationary control cage (*F*) where it discharges to the bladed section of the wheel. At this point, the abrasive is picked up by the inner ends of the throwing blades (*E*) and it is gradually accelerated in its movement to the periphery of the wheel. Final throwing velocity is the result of radial and tangential forces.

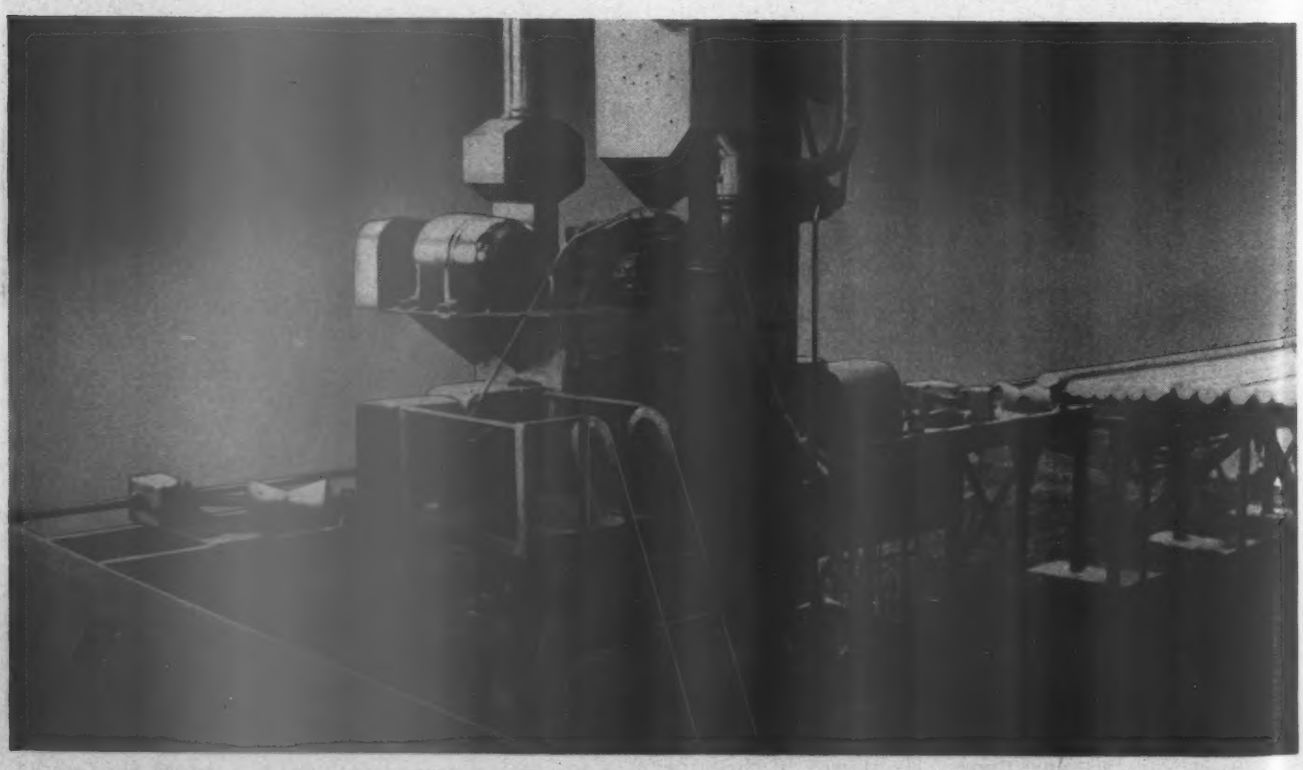


A key to the Wheelabrator parts

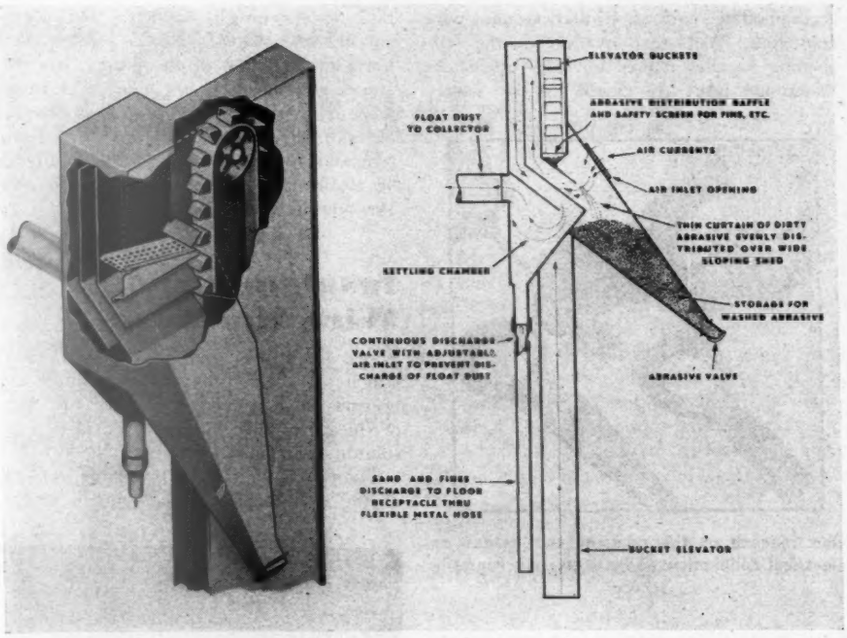
A—Abrasive funnel
B—Abrasive metallic shot or grit
C—Spacers between side plates
D—Special steel side plates
E—Removable cast alloy blades
F—Cast alloy control cage (stationary)
G—Cast alloy impeller (rotates with wheel)

After ragged ends have been cut off from the tubes or flues to be cleaned they are fed onto constantly rotating conveyor rolls leading to the blast cleaning cabinet. These skew-dished conveyor rolls serve to move flues through the Wheelabrator cabinet at speeds ranging from 8 ft. to 29 ft. per min. For 2-in. or 2¼-in. tubes the speed rate is between 15 ft. and 24 ft. per min. depending upon the condition and amount of scale to be removed. Speed is manually controlled by the operator in charge.

All rolls are driven by bevel gears and a line shaft. A one-horsepower motor, operating through variable-speed reducers, is required to operate the conveyor. Rolls inside the blast cabinet are made of special abrasive-resisting metal to withstand the severe service to which they are subjected. Rolls outside the cabinet, not subject to abrasive wear, are cast iron. These conveyor rolls are set at such an angle that they serve to rotate the flues as they pass through the cabinet in the path of the blast.



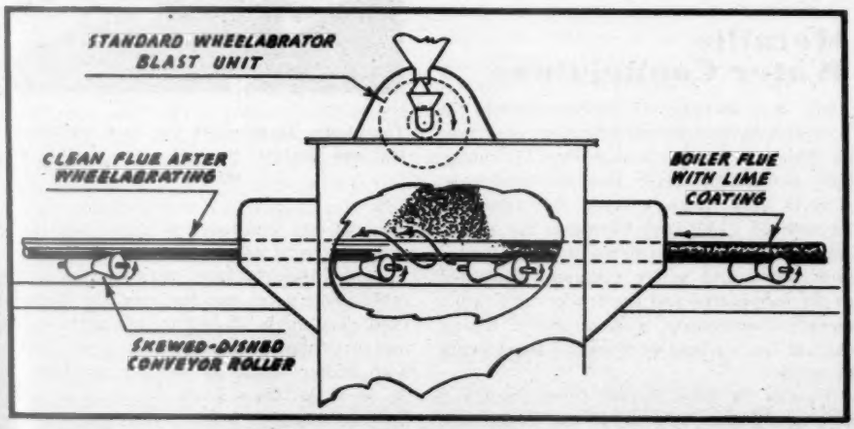
The Wheelabrator utilizes controlled centrifugal force instead of an air blast for abrasive cleaning


ELEVATOR BUCKETS
ABRASIVE DISTRIBUTION BAFFLE AND SAFETY SCREEN FOR FINES, ETC.
FLOAT DUST TO COLLECTOR
AIR CURRENTS
AIR INLET OPENING
THIN CURTAIN OF DIRTY ABRASIVE EVENLY DISTRIBUTED OVER WIDE SLOPING SHED
SETTLING CHAMBER
STORAGE FOR WASHED ABRASIVE
CONTINUOUS DISCHARGE VALVE WITH ADJUSTABLE AIR INLET TO PREVENT DISCHARGE OF FLOAT DUST
ABRASIVE VALVE
SAND AND FINES DISCHARGE TO FLOOR RECEPTACLE THRU FLEXIBLE METAL HOSE
BUCKET ELEVATOR

A gravity type abrasive separator saves all shot and grit which can be reused

Depending upon the density of the scale to be removed, various sizes of metallic abrasives may be used. For ordinary cleaning metallic grit mixed with a small portion of shot has been found to be effective. Shot hits harder in breaking down heavy scale on the flues, while the grit abrasive has a greater cutting action. This mixture cleans the scale in pits on heavily pitted tubes as well as breaking down and removing scale on unpitted portions of the tube wall. When shot is used alone the surface resulting is fairly smooth but indented; grit produces a rougher finish. Variations in finish can be obtained by using various sizes of shot, of grit, or of both.

The abrasive and scale resulting from the blasting operation are carried by a bucket elevator to a combination abrasive separator and storage hopper. Here it is distributed in a thin curtain over an inclined shed. In flowing off the shed, the abrasive and scale passes over an air duct before falling into the storage bin. The current of air in this duct is drawn through the abrasive and scale curtain and carries away the sand, dirt and abrasive fines into a settling chamber which empties into a receptacle on the floor. Any remaining fine dust is carried in the exhausted air to a dust collector. Usable abrasive, which is deposited in the storage hopper, is fed to the Wheelabrator unit under valved control for recycling.

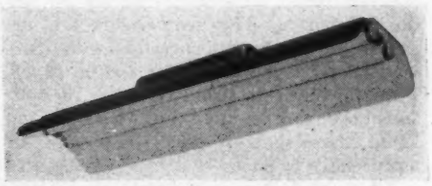

STANDARD WHEELABRATOR BLAST UNIT
CLEAN FLUE AFTER WHEELABRATING
BOILER FLUE WITH LIME COATING
SKEWED-DISHED CONVEYOR ROLLER

Boiler tubes travel through the cleaning cabinet at rates of speed depending on their sizes and scale condition

Composition Fluorescent Fixtures

Sylvania Electric Products, Inc., Ipswich, Mass. (formerly Hygrade Sylvania Corp.), announces eight new industrial fluorescent fixtures with composition reflectors. The manufacturer states that their reflection factor is even greater than that of porcelain enameled steel reflectors.

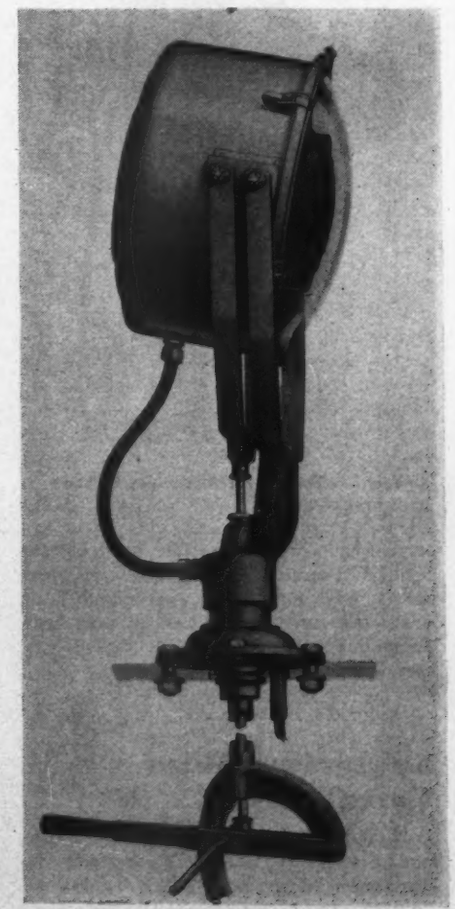
The fixtures range in size from 100 to 300 watts, and are available for either individual or continuous-row mounting. The reflectors are finished in Miracoat baked white enamel, and the outside of the units in French gray. The units are furnished complete with lamps and Mirastat starters. Slide-Grip hangers are included with all continuous-row models.



A fluorescent lighting unit with two 40-watt lamps, for individual mounting

Searchlight

Revere Electric Mfg. Company, Chicago, announces the development of dust, bug and weather-tight incandescent searchlights for varied industrial uses. They are available with 12- and 18-in. lenses and are particularly suited for protective lighting at ordnance plants, industrial plants, bridges, oil storage yards, public utilities, aboard ships or other patrol lighting needs. They offer a multiplicity of mounting arrangements to suit any condition, including pilot house control.



Searchlight with pilot house mounting

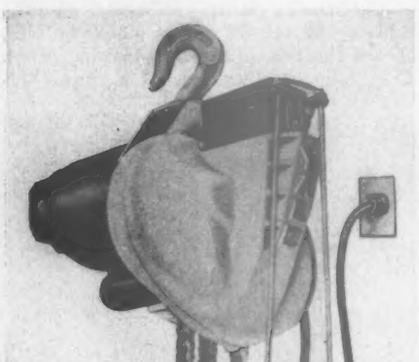
A beam of high candle power is pro-

duced by a precision ground polished silvered glass reflector, as well as an accurate polished metal secondary reflector for added efficiency. The searchlights are designed for continuous operation with 1500-watt lamps in the 18-in. size and up to 600 watts in the 12-in. size. Wattages of 2,000 and 1,000 can be used in the 18-in. and 12-in. searchlights respectively if used intermittently.

When used in a pilot house, the unit is equipped with a friction clutch and rotation stop. The elevating quadrant is furnished with degree markings for setting at any predetermined angle.

Portable Electric Hoists

Electric hoists in capacities of ⅛, ¼, ½ and 1 ton are being manufactured by the Yale & Towne Mfg. Co., Philadelphia Division, Philadelphia, Pa., and distributed under the name Midget King. The hoists are made as either alternating or direct-current units. Light enough in weight to be readily carried about a shop, the hoists are available for service wherever there is an electric outlet and a place to hang them. All units are tested with a 50-per-cent overload before they leave the factory.



Yale & Towne portable electric hoist

Solderless Wire Terminals

A "Hand-die" installation tool for applying lug terminals to electric wires and cables is now being made by Aircraft-Marine Products, Inc., Elizabeth, N. J.

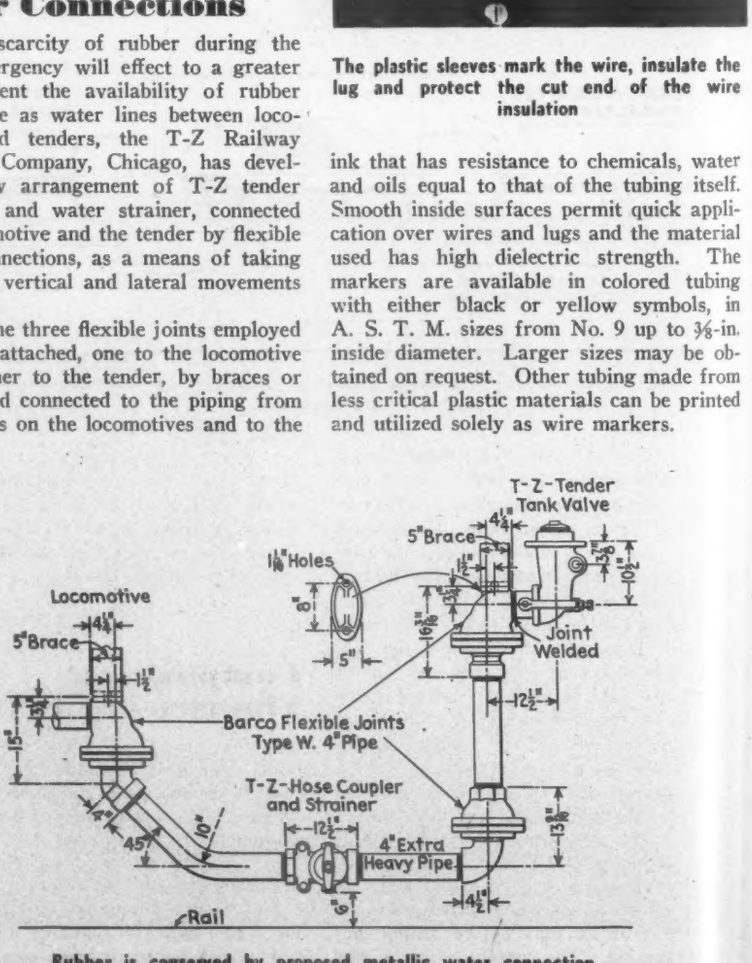
The tool makes three crimps in the lug to produce an electrical and mechanical connection with the wire. An insertion gauge automatically positions the terminal. The crimping jaws for both wire and insulation are tool-steel dies adjustable to accommodate various insulation and wire diameters. A 15-to-1 leverage on the self-opening handles makes for easy operation. When the jaws are closed tightly, a perfectly crimped connection has been made; there is no choice of pressure necessary by the operator. Wire sizes are marked on the tool which may be made left or right handed as needed.

One squeeze of the crimping tool makes an electrical connection which is also mechanically secure

Metallic Water Connections

Since the scarcity of rubber during the present emergency will effect to a greater or less extent the availability of rubber hose for use as water lines between locomotives and tenders, the T-Z Railway Equipment Company, Chicago, has developed a new arrangement of T-Z tender tank valve and water strainer, connected to the locomotive and the tender by flexible metallic connections, as a means of taking care of the vertical and lateral movements in service.

Two of the three flexible joints employed are rigidly attached, one to the locomotive and the other to the tender, by braces or supports and connected to the piping from the injectors on the locomotives and to the tank valves on the tender. A T-Z hose coupler and water strainer, applied on the horizontal portion of the piping, has three functions; it can be quickly separated when the tender is to be removed from the locomotive; the strainer may be readily removed for cleaning, and the piping can be drained at its lowest point to avoid bursting in winter weather.



Rubber is conserved by proposed metallic water connection between locomotive and tender

Insulators and Wire Markers

Short lengths of extruded plastic tubing which serve as insulators of terminal connections and as wire markers are being produced by the Irvington Varnish & Insulator Company, Irvington, N. J.

The tubing is marked in legible numerals of the customer's choice, printed with an ink that has resistance to chemicals, water and oils equal to that of the tubing itself. Smooth inside surfaces permit quick application over wires and lugs and the material used has high dielectric strength. The markers are available in colored tubing with either black or yellow symbols, in A. S. T. M. sizes from No. 9 up to ⅜-in. inside diameter. Larger sizes may be obtained on request. Other tubing made from less critical plastic materials can be printed and utilized solely as wire markers.

The plastic sleeves mark the wire, insulate the lug and protect the cut end of the wire insulation

High Spots in
Railway Affairs . . .

Railroaders Commended For Buying War Bonds

Three railroads have thus far received certificates of award from the U. S. Treasury Department for going over the top in the purchase of War Bonds under the 10 per cent payroll savings plan. They include the Boston & Maine, the Mississippi Central and the Lehigh & New England.

Are We Dumb?

As one knocks about the country he cannot but be impressed by the fact that many railway employees take a considerable interest in community and public affairs. The Railroad Y. M. C. A. has aggressively promoted citizenship training and public affairs discussions for a number of years, and more particularly since its Commission on Responsible Citizenship was set up in 1939. It has even gone so far as to compile and publish a Citizenship Training Manual. A survey made by the magazine Fortune and based on nine simple questions relating to current affairs indicates that 38 per cent of the railway employees are "poorly informed" and 35 per cent "uninformed." Only about 27 per cent, therefore, are rated as being "well informed." It is not surprising to learn that railroaders, at that, were not rated at the bottom of the list in Fortune's report. Railroad men do get around a good bit and transportation is so fundamental to American economy that railroad employees would naturally be expected to have a broader perspective than workers in many other fields. Lower percentages of "well informed" were found among factory, personal-service and mining employees.

First-Quarter Car Loadings

Our American economy is being badly upset by war conditions and it is becoming increasingly difficult to estimate very far ahead just what will be the civilian requirements for rail transportation. Every day, these winter months, new rules or suggestions are being made for rationing, or as to the restriction of production along non-essential lines—that is, non-essential from the viewpoint of waging war. One of the best gages for forecasting freight traffic is the estimates made by the thirteen Shippers Advisory Boards. Eight of the thirteen boards estimate an increase of freight car loadings on the 28 principal commodities during the first quarter of 1943. The Pacific Northwest, the Trans-Missouri-Kansas, the Southeast, the Atlantic States and the New England boards estimate decreases. The net result, however, is a prediction that freight car loadings, as a whole, will be increased about 3.4 per cent over the loadings in the first quarter of 1942. An increase is expected in the loading of 10 of the 28 commodities; among these are cotton seed and products, except oil, 22.2 per cent; manufactures and miscellaneous, 18.4 per cent; livestock, 14.6 per cent; grain, 10.9 per cent, and potatoes, 10.5 per cent. Some of the more important commodities for which decreases are estimated include agricultural implements and vehicles other than automobiles, 45.4 per cent; sugar, syrup and molasses, 18.4 per cent; paper, paper board and prepared roofing, 10.7 per cent, and lime and plaster, 10.3 per cent.

Pullman Carries Troops

The Pullman Company made a remarkable record in 1942. It handled 18 million civilian passengers, carrying them a total of 10 billion passenger-miles and breaking all records since 1931. At the same time it transported more than eight million soldiers, sailors and marines a total of more than nine billion passenger-miles. The troop movements are being made by a mobile fleet of more than 7,000 cars, which are set aside for seasonal, holiday or emergency peaks in business. This troop movement was not spread evenly over the year, but has increased steadily ever since Pearl Harbor. During the last three months of 1942 the rate was at more than 800,000 per month.

Tribute to Uncle Sam

In the early days of this country many of the railroads were encouraged to extend their lines into undeveloped territories because of land grants from the federal or state governments. This proved to be a good bargain for both parties. It opened up the country to settlers and facilitated its development, and at the same time reacted to the advantage of the railroads. Jefferson, when President in 1803, made the statement that it would be a thousand years before the region east of the Mississippi could be fully settled. But Jefferson reckoned without the railroads! They made possible the speedy opening up and development of the Far West and the welding of the states into a greater nation. Uncle Sam, however, is frequently a sharp bargainer. The land grant roads were forced to carry government property at special rates. The story is told statistically and graphically in an exhibit which was recently released by the Transportation Board of Investigation and Research. Up to June 30, 1942, the savings to the government because of land grant reductions for carrying troops and government property amounted to more than $340,000,000. It is estimated that at the present time the savings amount to at least $20,000,000 a month. The report points out that the savings to the government in connection with traffic moving over land grant roads have accounted for a considerably smaller part of the total savings than have the equalization agreements entered into by non-land grant roads competing for government traffic. Uncle Sam is certainly being paid at a handsome rate for the land grants, and the ironical part of it is that the non-land grant roads are now making the greater part of the contribution.

Export Traffic and the Rails

The average number of cars of export freight unloaded at North American ports in 1942 was nearly 16 per cent greater than the number handled in 1918 in the first World War. The average tonnage per car in 1942, however, was much greater. The effect of waging wars on both oceans is indicated by the fact that one-third of the total export freight is now moving to Pacific ports; there was only a small amount in that direction in 1918. These movements of export freight are being handled without any congestion, or as expressed in a report of the Association of American Railroads, every port in the United States is in a completely "liquid" condition. Approximately 2,500 cars of export freight are now being unloaded daily.

Oil Shortage

The eastern part of the country is shivering in the attempt to struggle through the winter with poorly heated homes and buildings. Householders with well-filled coal bins in their cellars are wearing a smug expression of satisfaction, but those who are dependent on the current delivery of coal or on fuel oil or gas heating are anything but comfortable. The railroads continue to do an exceptionally good job in moving the oil, but seem to have about reached the maximum capacity of the present tank car equipment. The floods interfered somewhat with the movement during the latter part of the year, but the latest record available at this writing—that for the week ended January 2—shows that the daily tank car movement averaged 775,409 barrels, an increase of 74,582 barrels a day over the previous week. Some slight improvement has been registered by the shipment of kerosene in steel drums in box cars. The Army has made available 200,000 steel drums for this purpose and it is hoped to move about 6,500 barrels of kerosene daily by this method. Pipe-line pumping capacity is being increased, but it is not expected that substantial increases will be made in such deliveries until extensions of the Plantation Pipe Line into Virginia and the new line from the Ohio River to Philadelphia are placed in operation.

Among the Clubs and Associations

CAR DEPARTMENT OFFICERS' ASSOCIATION.—Owing to the pressure of other duties in connection with his recent promotion to the position of assistant to the vice-president of the Chicago, Burlington & Quincy, F. L. Kartheiser has tendered his resignation as secretary-treasurer of the Car Department Officers' Association after serving the association in this capacity for five years. The board of directors has appointed F. H. Stremmel, assistant secretary, Association of American Railroads, Mechanical division, to fill Mr. Kartheiser's unexpired term of office. The business of the Car Department Officers' Association will be conducted by the new secretary-treasurer from his office at 6536 Oxford avenue, Chicago.

EASTERN CAR FOREMEN'S ASSOCIATION.—Meeting held on January 8 in the Engineering Societies building, New York. ¶ The following were elected to serve for the year 1943: President, B. F. Cordts, engineer, cars and shops, Independent Subway System, New York; first vice-president, K. H. Carpenter, superintendent car department, Delaware, Lackawanna & Western, Scranton, Pa.; second vice-president, F. H. Becherer, superintendent car department, Baltimore & Ohio, Baltimore, Md.; treasurer, T. G. Case, general car foreman, New York Central, New York, and secretary, W. P. Dizard, 30 Church street, New York. ¶ Following the election of officers, a panel discussion was held relating to changes which have been made in the A. A. R. Rules of Interchange which were issued as of January 1, 1943. The discussion was led by G. B. Williamson, chief, A. A. R.

Five Awards Made by St. Louis Car Men

Car Department Officers Association of St. Louis.—Meeting held December 15 at St. Louis, Mo. Presentation of awards to winners of the contest for the best short paper presented by railroad men from the ranks during the 1942 season. ¶ Six papers in all were presented and awards made as follows: First prize of $25.00, to H. J. Flannigan, carman helper, Illinois Central —"Lubrication" presented at the meeting on April 21, 1942; second prize of $15.00, to G. H. Pollard, draftsman, Missouri Pacific—"Engineering in Connection with Car Construction and Maintenance," presented at the meeting on September 15, 1942; third prize of $10.00, to Ray C. Milz, foreman, Pullman Company—"Safety and the New Man," presented at the meeting on September 15, 1942. ¶ The other contestants, each of whom deserves praise for a very creditable effort, were awarded a prize of $2.00 each. They are: E. L. Schaffner, gang foreman, Pennsylvania—"Periodic Attention to Passenger Cars," presented at the meeting on March 17, 1942; E. F. Davis, electrical foreman, New York Central —"Conservation of Electrical Equipment by Close Inspection," presented at the meeting on May 19, 1942; and E. Warning, leadman, Missouri Pacific—"Responsibility of Repair Track Forces in Maintaining Equipment." presented at the October 20, 1942, meeting.

DIRECTORY

The following list gives names of secretaries, dates of next regular meetings, and places of meetings of mechanical associations and railroad clubs:

ALLIED RAILWAY SUPPLY ASSOCIATION.—J. F. Gettrust, P. O. Box 5522, Chicago.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. —H. H. Henleine, 33 West Thirty-ninth street, New York.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.— C. E. Davies, 29 West Thirty-ninth street, New York.

RAILROAD DIVISION. — E. L. Woodward, *Railway Mechanical Engineer*, 105 West Adams street, Chicago.

ANTHRACITE VALLEY CAR FOREMEN'S ASSN.— Victor H. Deppe, general secretary, Mountain Top, Pa. Meets January, March, May, July, September and November at Scranton, Pa. February, April, June, August, October and December at Wilkes-Barre, Pa.

ASSOCIATION OF AMERICAN RAILROADS.—Charles H. Buford, vice-president Operations and Maintenance Department, Transportation Building, Washington, D. C.

OPERATING SECTION.—J. C. Caviston, 30 Vesey street, New York.

MECHANICAL DIVISION.—A. C. Browning, 59 East Van Buren street, Chicago.

PURCHASES AND STORES DIVISION.—W. J. Farrell, Executive Vice Chairman, Transportation Building, Washington, D. C.

MOTOR TRANSPORT DIVISION.—George M. Campbell, Transportation Building, Washington, D. C.

CANADIAN RAILWAY CLUB.—C. R. Crook, 4415 Marcil avenue, N. D. G., Montreal, Que. Regular meetings, second Monday of each month, except June, July and August, at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT ASSOCIATION OF ST. LOUIS.— J. J. Sheehan, 1101 Missouri Pacific Bldg., St. Louis, Mo. Regular monthly meetings third Tuesday of each month, except June, July and August, DeSoto Hotel, St. Louis.

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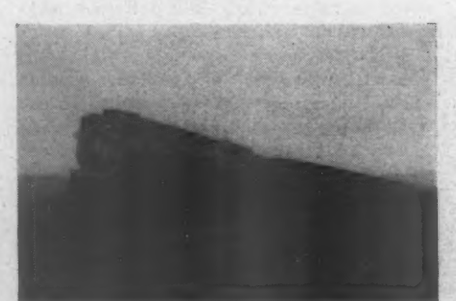

Photo by Hugh F. O'Neil

S. P.'s Second 88 Eastbound, Near Montello, Nev.

CAR DEPARTMENT OFFICERS' ASSOCIATION.—J. H. Stremmel, 6536 Oxford avenue, Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—W. J. Burns, second vice president, General American Transportation Corp., Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago.

CAR FOREMEN'S ASSOCIATION OF OMAHA, COUNCIL BLUFFS AND SOUTH OMAHA INTERCHANGE.— H. E. Moran, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month.

CENTRAL RAILWAY CLUB OF BUFFALO.—Mrs. M. D. Reed, Room 1840-2, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday of each month, except June, July and August, at Hotel Statler, Buffalo.

EASTERN CAR FOREMEN'S ASSOCIATION.—W. P. Dizard, 30 Church street, New York. Regular meetings, second Friday of January, February (annual dinner), March, April, May, October, and November at Engineering Societies Bldg., 29 West Thirty-ninth street, New York.

INDIANAPOLIS CAR INSPECTION ASSOCIATION.— H. T. Bramblett, care of H. P. Ruck, car foreman, Pennsylvania, 764 South Emerson avenue, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, in Indianapolis Union Station, Indianapolis, at 7 p. m.

LOCOMOTIVE MAINTENANCE OFFICERS' ASSOCIATION.—Secretary-treasurer C. M. Lipscomb, Missouri Pacific, North Little Rock, Ark.

MASTER BOILER MAKERS' ASSOCIATION.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y.

MIDWEST AIR BRAKE CLUB.—C. F. Davidson, secretary-treasurer, general inspector car department, St. L.-S. F., Springfield, Mo.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings second Tuesday in each month, except June, July, August and September, at Hotel Touraine, Boston, Mass.

NEW YORK RAILROAD CLUB.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Thursday in each month, except June, July, August, September and December at 29 West Thirty-ninth street, New York.

NORTHWEST CAR MEN'S ASSOCIATION.—E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings first Monday each month, except June, July and August, at Midway Club rooms, 1931 University avenue, St. Paul.

NORTHWEST LOCOMOTIVE ASSOCIATION.—G. T. Gardell, 820 Northern Pacific Building, St. Paul, Minn. Meetings third Monday of each month, except June, July and August.

PACIFIC RAILWAY CLUB.—William S. Wollner, P. O. Box A, Sausalito, Calif. Regular meetings, second Thursday of each alternate month at Palace Hotel, San Francisco, Calif., and Hotel Hayward, Los Angeles.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 308 Keenan Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

RAILWAY FUEL AND TRAVELING ENGINEERS' ASSOCIATION.—T. Duff Smith, Room 811, Utilities Building, 327 South La Salle street, Chicago.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION. —J. D. Conway, 308 Keenan Building, Pittsburgh, Pa.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.— A. T. Miller, 4 Hunter St., S. E., Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

TORONTO RAILWAY CLUB.—D. M. George, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July, and August at Royal York Hotel, Toronto.

WESTERN RAILWAY CLUB.—E. E. Thulin, executive secretary, 122 South Michigan avenue, Chicago. Regular meetings, third Monday in each month, except June, July, August, September, and January, Hotel Sherman,

(*Turn to next left-hand page*)

A veritable flood of war materiel is pouring from American factories. The transportation of these finished tools of war and the enormous quantity of vital raw materials necessary in their production, depends almost entirely upon the railroads. Never before have the railroads produced so much transportation — under so much pressure! Chilled Car Wheels help keep freight cars rolling. ● More than 15,000,000 Chilled Car Wheels are now in freight service ● With 38 foundries strategically located in the United States and 8 in Canada, the railroads are assured of quick delivery and reduced wheel delivery costs. ● Under our unique wheel exchange plan, by which you receive new wheels for old on a conversion charge basis, scrapped chilled wheels are speedily melted and recast into new and better wheels. Thus, vital material is conserved, delivery of new Chilled Car Wheels is expedited, defense production is accelerated and Victory hastened.

ASSOCIATION OF MANUFACTURERS OF CHILLED CAR WHEELS

230 PARK AVENUE,
NEW YORK, N. Y.

445 N. SACRAMENTO BLVD.,
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ORGANIZED TO ACHIEVE:
Uniform Specifications
Uniform Inspection
Uniform Product

3196

NEWS

ODT'S "Claimant Agency" Status

OFFICIAL announcement of the fact that the Office of Defense Transportation had been made a "claimant agency" under the War Production Board's Controlled Materials Plan was made by WPB on January 8. To perform the functions thus developing upon ODT, Director Eastman on the following day announced the establishment of a Division of Material and Equipment Requirements, replacing the Section of Materials and Equipment.

As noted in the January issue, page 65, where the decision to make ODT a claimant agency was reported, the WPB action takes the transportation industry out from under the wing of the Office of Civilian Supply and gives it a place for itself on WPB's Requirements Committee which doles out available materials. The WPB announcement said that invitations to nominate members to represent them on that committee have been sent to the newly-designated claimant agencies.

"Claimant agencies," as the WPB announcement explained, "act as spokesmen for the various 'customers' using critical materials. They are responsible for making up and presenting their respective programs and compiling requirements of materials to meet them. This is being done both for current requirements and for future requirements to be submitted under the Controlled Materials Plan when it becomes effective April 1.

"Each claimant acts as proponent of its own program and carefully examines the programs of others. In this way views of all interested parties are expressed. After full discussions of the programs and requests of the respective claimants, the chairman of the Requirements Committee, with the advice of the committee, makes allotments of materials to meet definite approved programs If adjustments in individual programs are necessary as a result of the final allotment, the claimant is responsible for making them. The claimant is also responsible for seeing that the approved program is carried out."

The ODT organization change makes Warren W. Kelly, who has been director of the Section of Materials and Equipment, director of the new Division of material and Equipment Requirements. Mr. Kelly, former general purchasing agent of the Atchison, Topeka & Santa Fe, came to ODT last June. Associate director of the new division will be A. L. Sorensen, former manager of stores of the Erie who has been assistant to the vice-president, Operations and Maintenance Department, Association of American Railroads, since early last year. Carroll W. Brown, who has been assistant director of the replaced section, will continue as assistant director of the new division.

The changes, according to the ODT announcement, became effective January 1; and Mr. Kelly in his new role will report to General Charles D. Young, assistant director of ODT. The functions of the new division were summarized in the announcement as follows:

1. To gather from other divisions of ODT, and other sources, estimates of the requirements of domestic transportation for materials and equipment.

2. To compile these estimates into an over-all integrated domestic transportation requirements program for his approval.

3. To prepare the approved program for presentation to WPB.

4. To arrange, with the advice of other ODT divisions, proper allocations of materials and equipment in accordance with WPB's determination and allotment of the program's requirements.

5. To arrange for the necessary implementation, so that materials and equipment may be forthcoming in accordance with approved schedules.

6. To represent ODT on the various WPB Industry and Material Division Requirement committees.

7. To act as liaison between ODT and all government and private agencies on matters concerning material and equipment requirements for which ODT is claimant agency.

Authority Required To Scrap Old Locomotives

THE War Production Board by an amendment to its Limitation Order L-97 has established "regulatory control" over "the repair, sale, dismantling, scrapping or other disposition of surplus used or idle" locomotives, it was announced January 2. This order, it was said, paves the way for the pooling of surplus or idle used locomotives under regulations to be announced by the Office of Defense Transportation.

In its original form Order L-97 controlled production and distribution of new locomotives. It was pointed out that steadily increasing munitions and ordnance production creates a condition in which maximum use of all available motive power is essential, and repair of used equipment is expected to contribute to this end by adding to the supply of serviceable locomotives, at least for industrial operations, so releasing new equipment for purposes where they are most useful.

The amended order provides that a used locomotive cannot be scrapped or dismantled until specific authority is obtained from the WPB Director General for Operations. An application on Form PD-747 is necessary to get such authorization. The limitation order is administered by the WPB Transportation Equipment Division, but it was emphasized that that division will not control transfers of locomotives among railroads, which remains an ODT responsibility.

Motive Power Shortage Eased by Leasing

LATEST available reports are said by the Office of Defense Transportation to show that 469 freight locomotives, 65 passenger locomotives, 6 all-purpose locomotives, and 166 switching locomotives have been leased by railroads with a motive-power surplus to other roads suffering from serious power shortages. Such shifting of equipment from one road to another has promoted maximum use of motive power under wartime traffic demands, the ODT points out, and has averted difficult situations that threatened to develop before construction of the 386 new locomotives authorized in November, 1942, by the War Production Board.

Among instances cited by the ODT of leasing arrangements made as the result of co-operation between the railroads, the Association of American Railroads, and the ODT, is the transfer of locomotives to other roads from the Duluth, Missabe & Iron Range at the close of the Great Lakes navigation season. Of these, 4 went to the Denver & Rio Grande Western, 4 to the Great Northern, 3 to the Western Pacific, and 7 to the Southern Pacific. In addition, 2 new locomotives ordered by the D. M. & I. R. were delivered to the D. & R. G. W. for use until March, when, with the others, they will be turned back to the owning road as the iron ore move-

(*Continued on next left-hand page*)

Orders and Inquiries for New Equipment Placed Since the Closing of the January Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Types of Loco.	Builder
New York Central	25 [1]	4-8-2	Lima Loco. Wks.

FREIGHT-CAR INQUIRIES

	No. of Cars	Type of Car	Builder
Atchison, Topeka & Santa Fe	300	70-ton ballast	
	200	50-ton flat	
	200	70-ton gondola	
	200	50-ton hopper	
Western Maryland	25	70-ton flat	

[1] Authorized by WPB. Deliveries expected in July and August.

Typical of the care and accuracy with which Lima power is constructed, is the rod assembly jig illustrated above. The machined rods must fit on these jigs thus insuring interchangeability and avoiding the necessity of adjustment when the rods are applied to locomotives. This care in rod manufacture is one of the reasons why Lima-built locomotives "break-in" easily.

LIMA-BUILT *is Well Built*

To meet war-time traffic demands locomotives are being pushed harder than ever before. In today's emergency Lima-built power is proving its ability to take the increasing burden placed upon it.

The old railroaders at Lima know the service expected of their product and they go to unusual lengths in their manufacturing processes to build the longest possible life into each locomotive part.

This policy is paying dividends for the railroads in the present emergency.

LIMA LOCOMOTIVE WORKS — LIMA LOCOMOTIVE WORKS INCORPORATED — INCORPORATED, LIMA, OHIO

ment is resumed. By that time it is expected that new locomotives will reach the roads now leasing the D. M. & I. R. power.

Another example of locomotive transfer reported by the ODT involves three railroads. The D. & R. G. W., having obtained 10 Missouri Pacific locomotives, was able to lease 10 of its own to its western connection, the Western Pacific. The Bingham & Garfield also obtained a locomotive from the Denver & Rio Grande Western.

The Chicago & North Western, which had 108 locomotives available for disposal to other roads, has sold some of these to the Mexican government, the ODT states, but most of them have been leased. Roads now using C. & N. W. power include the Atlantic Coast Line, Southern, Seaboard Air Line, Missouri Pacific, and Kansas City Southern. Variations in clearance limitations, load limits, signal equipment and other conditions have restricted the scope of the leasing program, the ODT adds.

Co-operation between railroads to meet the wartime emergency has not been confined to locomotive leasing, the announcement continues, and about a dozen roads have undertaken repair work on off-line locomotives. One large project of this nature, shared by several roads, was the repair of 50 used locomotives sold by various roads to Mexico. In addition, the Norfolk & Western has repaired 52 locomotives for other roads, including 14 for the Atlantic Coast Line and 32 for the Seaboard Air Line.

Greater Use of Bessemer Steel Mandatory

RAILROADS and builders of locomotives freight and passenger cars and equipment specialties were notified in a circular dated January 7, and issued January 18 by the Transportation Equipment Division of the War Production Board, that all orders placed by them following that date for certain items of steel for railroad equipment which have usually been made of open-hearth steel, must clearly allow the substitution of Bessemer steel as an alternative in filling the order.

The new rules, which were invoked to reduce the demand for open-hearth steel, by increasing the utilization of the bessemer process of making steel, extend to 66 items of materials, and further require that all flanging must be formed by the hot rather than by the cold process. The items of material embraced in the order and the instructions governing their purchase, as announced by WPB, are as follows:

To All Railroads, Locomotive Builders, Car Builders and Specialty Manufacturers:

In order to reduce the demand for open-hearth steel for new equipment and repairs, it is requested that, when ordering steel, the purchase order shall specify "either open-hearth or bessemer steel."

1. On flat rolled plates under 7/16-in. thick and structural shapes, when not subject to high stresses, dynamic shocks, severe forming, or cold flanging.

2. Also on items listed below:

Freight Cars	Passenger Cars
Diaphragm web plates except bolster and crossbearer	Diaphragm web plates except bolster and crossbearer
Diagonal braces	Side sheets
Center sill separators	Roof sheets
Floor stringer connections	Corner caps
Floor beams	Branch pipe supports
Door headers	Diagonal brace gussets
Hood sheets	Reservoir supports
Inside finish	Unflanged side sheets
Side doors	Unflanged slope sheets
False floor sheets	

Locomotives

Deflecting plates	Ash pan material
Ex. inj. water reg. rigging	For stoker manifold shield
Booster air manifold bracket	Dome finish body
Door shield s. box ft.	Sand box body
Steam pipe cover	F. bumper step splash plate
Exh. inj. separator support	F. bumper step back plate
Cylinder jacket	Boiler jacket material
Oil pipe bracket	Gage stand (air gage booster and valve pilot)
Mech. lub. oil pipe brackets	Gage stand (stoker and ex. inj.)
Driv. box oil pocket	Gage stand (pyrometer)
Cen. pin. lub. on front foot plate	Valve handle support
Draw pin cover	Cab apron
Frame chafing plate	Cab seat details
Cab bracket	Cab material plates
Tank coal grate plates	Running board plates
Ten frame washout	Running board step
Bumper step kick plate	Engineer's tool box plates
B. bumper step plate splash	Side sheet
Tend. stoker material	Cab vent shaft support
Tank stoker compt. door	Cab seat plate (engineer)
Marker lamp box	Cab drop seat plate
Trainman's cab mat'l	Trailer truck box oil cavity
Trainman's cab drop seat mat'l	Staybolt flexible sleeves unless drop forged
Radial buffer shield	

For such of the above named parts that require flanging, hot flanging only is permitted and the flanged parts must be carefully inspected to see that no defects appear in the flanged corners.

A Second Railway Battalion to Train on the Southern

BECAUSE of the satisfactory manner in which the Southern Railway System trained its own 727th Engineer Battalion—the first of several railroad battalions organized to operate military railroads—the War Department has selected the Southern for the training of another Battalion, it has been announced by Brigadier General Carl R. Gray, Jr., General Manager of the United States Military Railway Service.

The 715th Operating Battalion will receive basic training in all phases of railway operation on the Southern's line between Meridian, Miss., and New Orleans, La., where the 727th underwent training during the latter part of 1942. Headquarters will be located at Hattiesburg, Miss.

Box Cars Refitted for Troop Transportation

THE Pennsylvania has recently brought out new models of the reconditioned box cars on which it has been working with the idea of converting them for use in the transportation of troops. The new models, embodying changes suggested by the Army and Navy after the preliminary demonstrations, have been assembled into an experimental train consisting of a sleeping car, a kitchen car, and a recreation car.

The sleeping car provides space for 32 men in three tiers of bunks; it has portholes for windows, is heated, fireproof, and has sanitary facilities. It has been suggested that the equipment might be used for long-haul troop movements, making it up into 16-car trains consisting of 14 sleepers, and the kitchen and recreation cars. Among those who have inspected the equipment is Director Eastman of ODT who is reported to have been favorably impressed. Meanwhile, the Pennsylvania is understood to be prepared to proceed with the conversion work if the idea receives the approval of the armed services.

Icy Tender Violation of Law

RAILROADS are bound to provide equipment in condition safe to be used, and to maintain it in that condition at all times while it is being operated, the United States Supreme Court has decided, and are liable for injuries suffered by employees on duty resulting from failure to maintain it in such condition without regard to negligence on its own part or that of the employee.

The particular case on which this opinion of the court was based, as announced January 11, is *Lilly versus Grand Trunk Western.*

The employee involved was a brakeman who slipped on ice on a locomotive tender tank while attempting to pull a water spout into position over the tender manhole, then fell to the ground, suffering injuries for which he sought damages. A jury in an Illinois state court returned a verdict in favor of the brakeman, awarding him $32,500 damages, but on appeal the state Appellate Court entered judgment for the railroad. After the Supreme Court of Illinois had refused leave to appeal, the case was taken to the United States Supreme Court, which reviewed the case because it involved interpretations of federal statutes, particularly the Boiler Inspection Act.

As the circumstances are outlined in the Supreme Court opinion, delivered by Justice Murphy, at the time of the accident the surface between the tender manhole and the fuel space, an area of some six square feet, was covered with ice; there was or had been a small leak at the collar of the manhole from which water flowed onto this surface; the brakeman stood on this icy surface while reaching with a rod for the water spout; and as he pulled on the spout his feet slipped on the ice and the rod at the same time slipped on the spout, causing him to lose his balance and fall to the ground.

In the trial court the jury was required to determine whether or not there was a leak in or near the manhole collar at the time of the accident, and this question was answered in the negative. On that ground the railroad's counsel contended, and the appellate court decided, that all question of violation of the Boiler Inspection Act was removed from the case, that there was no evidence of negligence and that the employee assumed the risk, if any.

In reviewing the case the Supreme Court considered two points: (1) Did the presence of ice on the tender top constitute violation of the Boiler Inspection Act irrespective of any leak in the manhole collar; and (2) Was the jury properly instructed in this respect?

To both questions the court's answer is affirmative.

(*Continued on next left-hand page*)

how to AVOID keeping locomotives WAITING FOR REPAIR PARTS!

Franklin is frequently urged to rush repair parts for locomotives undergoing repairs.

Today the delays caused by wrong priorities, difficulty in obtaining materials and the concentration of machines on war work, make it almost impossible to give the former prompt response to such requests.

For your own protection we suggest ordering currently against requirements that you know will be called for by planned maintenance schedules.

This is permissible under WPB regulations and will prevent delay in restoring locomotives to service.

FRANKLIN RAILWAY SUPPLY COMPANY, INC. NEW YORK CHICAGO

In Canada: FRANKLIN RAILWAY SUPPLY COMPANY, LIMITED, MONTREAL

"Negligence," the court ruled, "is not the basis for liability under the Act." Citing section 2 of the Act—which reads in part, "It shall be unlawful for any carrier to use or permit to be used on its line any locomotive unless . . . all parts and appurtenances thereof are in proper condition and safe to operate in the service to which the same are put, that the same may be employed in the active service of such carrier without unnecessary peril to life or limb"—the court remarks that use of a tender covered with ice does involve "unnecessary peril to life or limb." In support of its conclusion it refers to rule No. 153 of the Interstate Commerce Commission that the "top of tender behind fuel space shall be kept clean and means provided to carry off waste water." Here, it says, the word "clean" involves the "continuing duty" of removing "all extraneous substances" which might make standing hazardous.

The court finds without merit the contention of counsel that the Boiler Inspection Act applies merely to defects on construction or mechanical operation, and remarks that "without limitation" the Act refers to equipment "in proper condition and safe to operate."

Continuing, the Act says, "Conditions other than mechanical imperfections can plainly render equipment unsafe to operate without unnecessary peril to life or limb."

In reaching its conclusion on the second question considered by it, the Supreme Court decided that the jury was properly instructed in the trial court, so that no technical ground for reversing the verdict could be found in this contention.

Having ruled that the brakeman's injuries were the result of violation of the Boiler Inspection Act by the railroad, the questions of contributory negligence and assumption of risk are not available, the court's opinion reads, under sections 3 and 4 of the Federal Employers' Liability Act, "as those sections existed at the date of the accident."

This disposition of the case, it says, makes it unnecessary to consider either whether the railroad was generally negligent, or, if it was in fact negligent, whether the 1939 amendment to section 4 of the Employers' Liability Act—which completely abolishes the defense of assumption of liability of risk by the employee—should be applied retroactively.

1942 Traffic Tops All Records, Pelley Says

CALLING railroad performance last year "one of the outstanding features in connection with the prosecution of the war," J. J. Pelley, president of the Association of American Railroads, in a year-end statement, emphasized that the 1942 traffic comprised the greatest volume that "any form of transportation in the world has ever been called upon to move in any corresponding period."

Reviewing the year, Mr. Pelley said:

"Despite the unprecedented volume, railroads transported it without congestion. Some temporary stringencies in certain types of equipment have occurred but there has been no interference with the war effort because of inability of shippers to obtain cars. The volume handled by the roads amounted to 630,000,000,000 ton-miles. This was 155,000,000,000 ton-miles, or nearly 33 per cent greater than that handled in 1941, the previous record year. It was more than one and one-half times the volume moved in the first World War year 1918.

"This heavy increase in ton-miles resulted from the heavier loading of freight cars and longer haul per ton, carloadings in 1942 having been little more than one per cent greater than in the preceding year. Freight loadings approximated 42,800,000 cars in the current year, an increase of 510,000 cars above 1941.

"At the same time, railroads established a new high record in volume of passenger traffic in 1942. Passenger-miles (the number of passengers multiplied by the distance carried) totaled 53,000,000,000. This exceeded by more than 6,000,000,000 passenger-miles, or 13 per cent, the previous record established in 1920. It also exceeded 1941 by more than 23,000,000,000 passenger-miles, or 80 per cent.

"Part of this heavy passenger traffic in 1942 can be attributed to troop movements, approximately 2,000,000 members of our armed forces now being transported monthly in organized movements.

"Railroads have been able to meet transportation remands in 1942 because of improvements in equipment construction and a continuous improvement in operating efficiency. . . . The average speed of both freight and passenger trains in the current year was slightly less than in 1941 but this has been more than compensated for by the increase in the amount of freight and number of passengers carried per train.

"Among the outstanding efficiency records established by the railroads in 1942 were the following:

"1. Average load of freight per train was 1,030 tons, the highest on record. In 1941, it was 915 tons.

"2. Performance per freight train has more than doubled, gross ton-miles per freight train hour having increased from 16,555 in 1921 to 35,874 in 1942, while net ton-miles per freight train hour increased from 7,506 in 1921 to 16,216 in 1942.

"3. For each pound of fuel used in freight service in 1942, railroads hauled 9.2 tons of freight and equipment one mile compared with 6.2 tons in 1921.

"4. The average load per freight car was 31½ tons in 1942, the highest on record.

"5. The average haul of freight shipments in 1942 broke all records, increasing by approximately fifty miles compared with the preceding year.

"6. Average daily movement of freight cars was 49 miles in 1942, a new high record, and an increase of 90 per cent compared with 21 years ago.

"7. Average passengers per car and per train broke all previous records by a wide margin, the load per car being more than 40 per cent and the load per train being more than 60 per cent greater than in 1941.

"8. Average capacity of freight cars was 50½ tons in 1942, the highest on record.

"9. Average daily movement of freight locomotives in 1942 was 122.5 miles, or an increase of 57 per cent compared with 1921.

"10. Tractive force of locomotives averaged 52,000 lb., an increase of 40 per cent compared with twenty years ago.

"Railroads in the first eleven months of 1942 installed in service 60,789 new freight cars and 668 new locomotives. Demand for materials needed for other war purposes, especially steel, has resulted in a reduction in the amount of materials allocated by the government for new railroad equipment. Otherwise, the number of new cars and locomotives put in service this year would have been greater. The supply of certain types of equipment, such as flat, gondola and hopper cars, has been at times barely adequate to take care of traffic demands. Additional equipment will be needed to enable the railroads to continue to meet transportation demands. Expectations are that greater war activity may result in an increase of about ten per cent in ton-miles in 1943 compared with 1942. The War Production Board has announced a program for part of the coming year which will enable the railroads to purchase 20,000 new freight cars and 386 new locomotives, including both steam and Diesels.

"Capital expenditures in 1942 for equipment, roadway and structures and other improvements to property are estimated at $600,000,000 compared with $543,000,000 in the preceding year.

"Increased traffic as well as larger expenditures for maintenance work resulted in a further increase in employment on the railroads in 1942, the average number of employees having been 1,270,000, or an increase of 11.4 per cent compared with the preceding year. Annual earnings per employee in 1942 averaged $2,285, compared with $2,045 in 1941."

Correction

IN the article describing the Pennsylvania Class T-1 passenger locomotives which appeared in the January issue of the *Railway Mechanical Engineer*, mention was made of the Sellers Type E injector. The correct designation for the Sellers injector used on these locomotives is Type S.

Shippers See First-Quarter Loadings Up 3.4 Per Cent

FREIGHT carloadings in the first quarter of 1943 are expected to be about 3.4 per cent above actual loadings in the same quarter in 1942, according to estimates compiled by the thirteen Shippers' Advisory Boards.

On the basis of those estimates, loadings of the 28 principal commodities will be 7,712,290 cars in the first quarter of 1943, compared with 7,461,503 actual carloadings for the same commodities in the corresponding period in the preceding year. Eight of the 13 Boards estimate an increase in first-quarter loadings, but five (the Pacific Northwest, the trans-Missouri-Kansas, the Southeast, the Atlantic States and the New England Boards) estimate decreases.

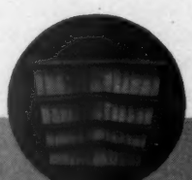
(Continued on next left-hand page)

TO HELP AMERICAN RAILROADS DO AN EVEN BETTER JOB

The continuous, uninterrupted movement of the tremendously-increased tonnages incident to our war effort calls for the fullest use of every steam locomotive.

One way to increase the availability of your power is through the application of Security Circulators to your existing locomotives. By so doing you obtain:

1. **Improved brick arch support for all locomotive fire boxes.**
2. **Improved circulation in side water legs.**
3. **Reduced flue plugging, cinder cutting and honeycombing.**



AMERICAN ARCH COMPANY, INC.

60 East 42nd Street, New York, N. Y.

SECURITY CIRCULATOR DIVISION

Supply Trade Notes

AMERICAN STEEL FOUNDRIES COMPANY.—*P. J. Sullivan* has been appointed sales agent of the American Steel Foundries, Chicago, with headquarters at St. Louis, Mo. Mr. Sullivan entered the employ of the traffic department of this company at

P. J. Sullivan

Chicago on November 25, 1905, and was later appointed assistant chief clerk in the order department. On December 13, 1921, he was promoted to manager of the order department, which position he was holding at the time of his transfer to St. Louis.

E. J. McQuaid succeeds Mr. Sullivan as manager of the order department. Mr. McQuaid was born in New York. He en-

E. J. McQuaid

tered the employ of the American Steel Foundries on April 6, 1920, and on June 1, 1942, was appointed assistant manager of the order department.

◆

STANDARD RAILWAY EQUIPMENT MANUFACTURING CO.—*A. A. Frank,* executive vice-president of the Standard Railway Equipment Manufacturing Co., Chicago, has been elected president to succeed Walter P. Murphy, whose death on December 16 was reported in the January issue. At the same time Mr. Frank succeeds Mr. Murphy as president of the Standard Railway Devices Company, of which he was vice-president; The Standard Railway Equipment Manufacturing Co. (Canada), Ltd., of which he was executive vice-president; and the Railway Metal Products Company. Mr. Frank will continue as president of the Standard Railway Equipment Company. He takes over his additional duties with a background of mechanical experience in actual railroad operation and long experience in the merchandising of products for railway use. After attending grammar school, he studied mechanical engineering and contract law. He entered railway service as a clerk in the transportation department of the Missouri Pacific, and after serving as a car distributor and as chief clerk, transferred to the mechanical department, where he worked as statistician and chief clerk. On April 14, 1911, he resigned to become secretary to Mr. Peter H. Murphy, who was then president of the P. H. Murphy Company (now part of the Standard Railway Equipment Manufacturing Company) and in 1913 was appointed manager of the company's plant at New Kensington, Pa. For three years, 1915-1917, he was sales agent of the Standard Railway Equipment Company at St. Louis, Mo., and in 1918 was elected vice-president in charge of sales of this company at Chicago. In January, 1921, he was elected president of this company and also

Arthur A. Frank

vice-president of the Union Metal Products Company (now a part of the Standard Railway Equipment Manufacturing Company). On January 1, 1939, Mr. Frank was also elected executive vice-president of the Standard Railway Equipment Manufacturing Company, Chicago, and on December 22, 1942, was elected president.

◆

WYANDOTTE CHEMICALS CORPORATION.—The J. B. Ford Company and Michigan Alkali Company, its affiliate, have consolidated as one company known as Wyandotte Chemicals Corporation. *E. M. Ford,* formerly a director of the J. B. Ford Company, is president of the new corporation. The sales departments of both companies will temporarily maintain their separate identities as divisions of Wyandotte Chemicals Corporation. *C. B. Robinson,* vice-president in charge of sales of the J. B. Ford division, will continue to promote the sale of Wyandotte cleanser to railroads and other industries not specifically assigned to the Michigan Alkali Division. The

C. B. Robinson

Michigan Alkali Division, of which *Bert Creamers* is vice-president in charge of sales, will handle, in addition to war production, sales in other industries such as aluminum, glass, etc., as well as railway sales.

◆

NATIONAL MALLEABLE & STEEL CASTINGS COMPANY.—*Wilson H. Moriarty* has been promoted to the position of assistant to the president, as announced in the January issue. Mr. Moriarty was graduated from the Case School in 1918 and served as an officer in the heavy artillery during the first world war. After a training period he became resident inspector at National Malleable's Cleveland, Ohio, plant and later held

Wilson H. Moriarty

similar positions in the East St. Louis, Mo., and Chicago plants. In 1927 he was appointed chief inspector for all of the company's plants. Three years later he was appointed sales engineer at the Cleveland plant, and in 1939 became that plant's sales manager. He was promoted to the position of assistant to the first vice-president in June,

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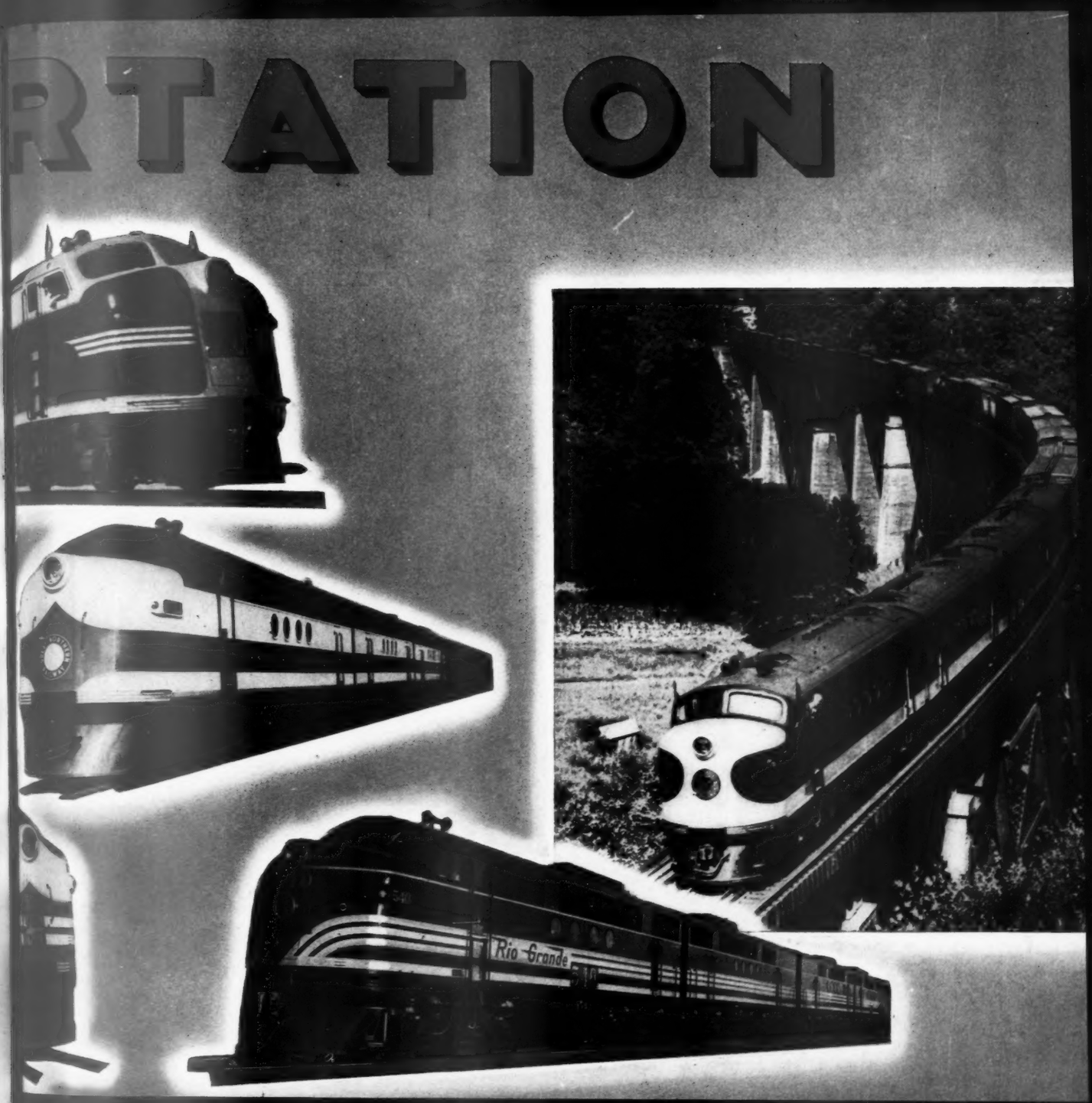

GM DIESELS MEET THE CHALLENGE

TO "Keep 'em Rolling" in 1943, railway motive power will have to keep step with the ever-increasing war-time traffic. To meet this demand, existing locomotives must be kept in maximum repair and new locomotives will be provided as authorized by the War Production Board. In the selection of new power, maximum performance and economy and minimum use of critical materials are of major importance. General Motors Diesel Road Locomotives make possible greater hauling capacity — reduction in train miles as much as 50 percent — faster schedules — greater availability — release for other important services as many as five heavy steam locomotives for each Diesel locomotive operated — increased carrying capacity of existing track facilities resulting in less wear and tear on rail and bridge structures. And in the *conservation of vital materials*, one ton of materials in a GM Diesel locomotive will do the work of more than two tons of materials in a steam locomotive.

THE AMERICAN WAY WILL WIN

GENERAL MOTORS
LOCOMOTIVES

1942. Mr. Moriarty has been instrumental in developing and perfecting several types of malleable iron and steel castings now used in war production.

Walton L. Woody, the newly appointed assistant to the president in charge of the Sharon, Pa., and Melrose Park, Ill., steel

Walton L. Woody

castings plants, joined National Malleable's Indianapolis, Ind., plant in 1914, immediately after graduation from the Rose Polytechnic Institute, Terre Haute, Ind. He was transferred to Cleveland in the same year and established the company's first chemical laboratory. He later became metallurgist and assistant superintendent in Cleveland, and in 1925 was appointed plant manager. In 1926 he acted as manager of the Chicago plant, returning to Cleveland later in the same year, where he remained until 1938, when he became plant manager at Sharon. Mr. Woody directed the modernization of the Cleveland, Sharon and Melrose Park plants. Under his direction the Sharon and Melrose Park plants are now completing expansion programs to take care of steel castings for tanks and anchor chain for the U. S. Navy, in addition to their usual railroad work. Several years ago he perfected for industrial use the triplex and duplex methods of melting malleable iron. Mr. Woody is a director of the American Foundrymen's Assn.

WAUGH EQUIPMENT COMPANY.—*Samuel Berman*, electrical test engineer of the New York independent subway system and inventor of the Berman Metal Locator, has joined the Waugh Laboratories, a division of the Waugh Equipment Company, where he will specialize on electronic work. Mr. Berman is the inventor of the electro-magnetic foreign body finder which helped to save many of the lives of men wounded at Pearl Harbor by promptly locating shell and bomb fragments so that they could be removed. The Locator is now in production at the Waugh Laboratories.

Obituary

CHARLES A. KROPP, chairman of the board of the Kropp Forge Company and the Kropp Forge Aviation Company, Chicago, died on December 17 at his winter home at Miami Beach, Fla. Mr. Kropp was born at Annefors Bruk, Sweden, on June 26, 1865, and migrated to the United States in the late 80's. The present Kropp

Charles A. Kropp

Forge Company had its roots in the water-powered forge shop founded by Mr. Kropp's father in 1837 at Annefors, Sweden, where C. A. Kropp learned his trade. In 1901, Mr. Kropp organized one of Chicago's earliest job forging shops, the Sundberg-Kropp Company, from which the present Kropp Forge Company and subsidiaries have evolved. Mr. Kropp had been inactive the last several years, spending most of his time at his Florida and Round Lake, Ill., homes.

◆

JOHN S. Y. FRALICH, district engineer for the Westinghouse Air Brake Company, with headquarters at Chicago, died January 5. Mr. Fralich served his apprentice-

John S. Y. Fralich

ship in the Pennsylvania's shops at Altoona, Pa., and was in service there for two years as a machinist. He entered the employ of the Westinghouse Air Brake Company as a machinist in 1904, and subsequently became supervisor of shop tests under the direction of the engineering department. For many years he assisted in the development, testing and road service trials of new air brake apparatus while associated with the experimental division of the engineering department and as assistant to the mechanical engineer. He was transferred to the Chicago office in 1913, as assistant resident engineer, and in 1919 was appointed district engineer. Mr. Fralich was a member of the Central Air Brake Club, the Western Railway Club, and the American Society of Mechanical Engineers.

Personal Mention

General

A. H. OSTBERG, mechanical inspector, Lines East of the Missouri river, of the Chicago, Burlington & Quincy, has been appointed general mechanical inspector, Lines East, with headquarters as before at Chicago.

Master Mechanics and Road Foremen

W. S. RICH, assistant master mechanic of the Boston & Albany at Beacon Park, Allston, Mass., has been transferred to West Springfield, Mass.

C. F. BARNHILL, master mechanic of the Gulf division of the Gulf, Colorado & Santa Fe, retired on January 1.

J. D. NIMMO, general foreman of the Gulf, Colorado & Santa Fe at Cleburne, Tex., has been appointed master mechanic of the Gulf division with headquarters at Silsbee, Tex.

J. R. KEELEY, general foreman of the Virginian, with headquarters at Roanoke, Va., has been appointed acting master mechanic at Victoria, Va.

F. J. CARTY, master mechanic of the Boston & Albany at South Station, Boston, Mass., has been transferred to Beacon Park, Allston, Mass.

R. REYMOND has been appointed road foreman of engines of the London division of the Canadian National, with headquarters at Mimico, Ont.

W. G. GRAY, master mechanic of the Virginian at Victoria, Va., has been transferred to Elmore, W. Va.

A. H. RIEGER, road foreman of engines of the Quebec district of the Canadian National, has been transferred to the Montreal district, with headquarters at Joliette, Que.

P. M. ROOKER has been appointed road foreman of engines, Wilmington district of the Atlantic Coast Line.

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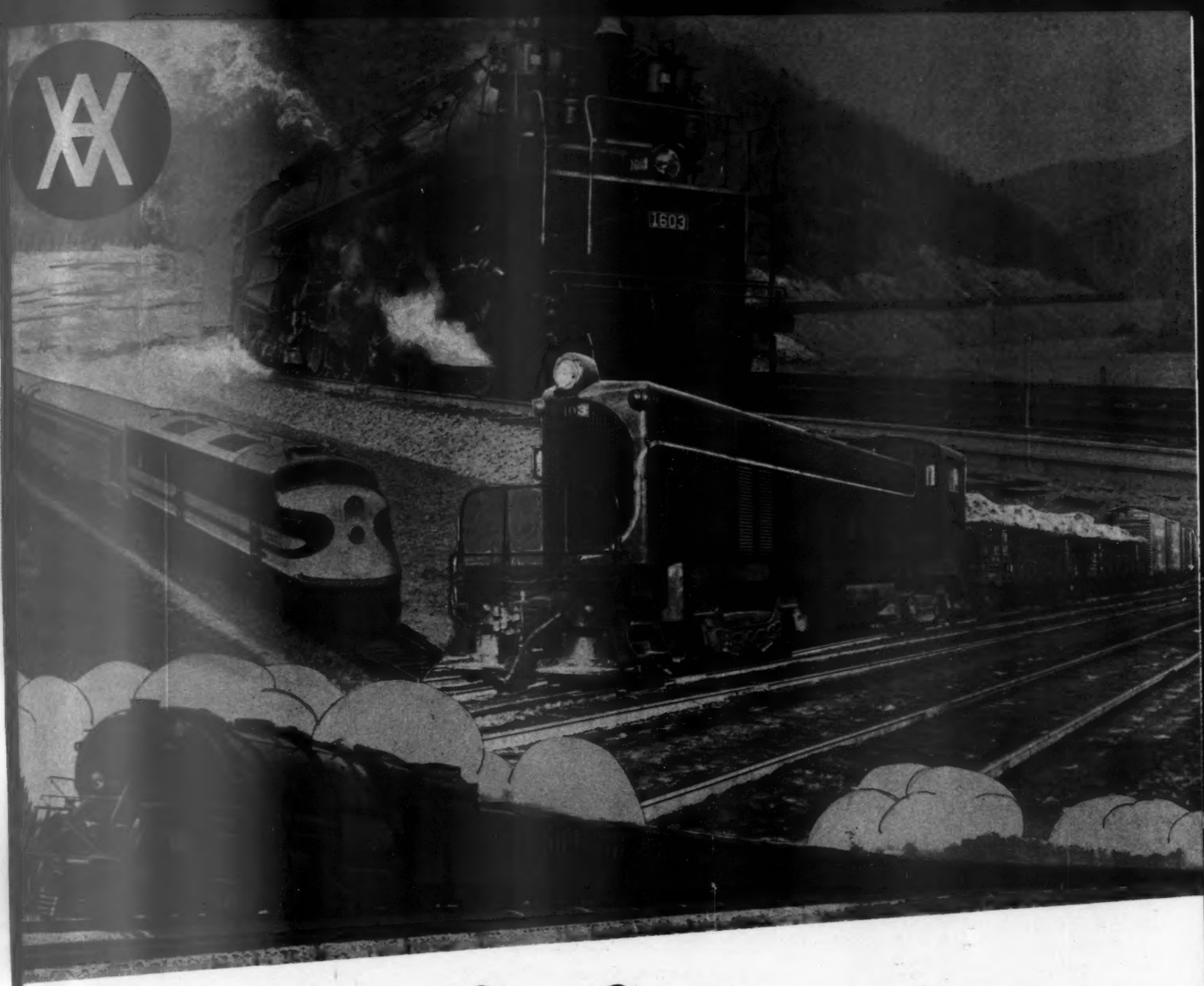

MODERN *Air Brakes* help Secure the MOST from Available Facilities

Smooth train handling — higher operating speeds in safety — adequate control for heavy tonnage trains — maximum flexibility for quick terminal shifting — reliable performance under rigorous duty — durability for long time service. These advantages accruing from the use of modern air brakes, adapted for specific requirements on various types of equipment, are helping to expedite volume shipments of vital wartime materials and supplies ★ Moreover, they will be an accumulating asset for peacetime transportation as an increasing proportion of locomotives and cars become equipped with this up-to-date apparatus. Now the demand is for quantity, time-saving, and continuity. Then, operating economy may be a major requirement, and you'll need the most of the best.

WESTINGHOUSE AIR BRAKE CO.
Wilmerding, Penna.

C. R. PATTERSON has been appointed road foreman of engines of the Canadian National of the Belleville division, with headquarters at Lindsay, Ont.

Car Department

J. D. REZNER, whose promotion to the position of superintendent of the car department of the Chicago, Burlington & Quincy with headquarters at Chicago as announced in the January issue, was born at Kirkwood, Ill., on July 13, 1893, and entered railway service on the Burlington in 1913 as an agent's helper at Kirkwood. In 1914 he became a car repairer at Alliance, Neb., and later served as a coach repairer and inspector at Omaha, Neb.; night foreman of train yard inspectors at McCook, Neb., and day foreman of train yard inspectors at Alliance. In February, 1919, he became assistant car foreman at Alliance and seven months later was promoted to the position of assistant general car foreman at Lincoln, Neb. Mr. Rezner was appointed assistant general car inspector of the

J. D. Rezner

Lines West of the Missouri river, with headquarters at Lincoln, in June, 1922, and in 1927, general car inspector, Lines East, with headquarters at Chicago. In January, 1931, he was transferred to the Lines West, with headquarters at Lincoln, and in September, 1937, he was appointed superintendent of shops at Havelock, Neb. Mr. Rezner was appointed general car foreman at Chicago in October, 1938, in which position he remained until his appointment as superintendent.

Purchasing and Stores

CHARLES C. HUBBELL, general purchasing agent of the Delaware, Lackawanna & Western at New York, who retired on January 1, as announced in the January issue, was born on March 1, 1870, at Columbus, Miss., and was educated at the Peekskill Military Academy. He entered railroad service in 1895 as a cashier in the employ of the New York & New Jersey Ferry Co. (now owned by D. L. & W.), and in 1898 became treasurer of the New York & Hoboken Ferry Co. (now owned by D. L. & W.). In 1903 he went with the Delaware, Lackawanna & Western as auditor of miscellaneous receipts. In 1909 he was appointed auditor of disbursements;

Charles C. Hubbell

in 1910, purchasing agent at New York, and in 1935 general purchasing agent at New York.

RUSSELL E. KING, assistant to the general purchasing agent of the Delaware, Lackawanna & Western, has been appointed to the position of purchasing agent at New York.

Obituary

WILLIAM JACOB, mechanical engineer of the Pere Marquette at Detroit, Mich., died on January 6 after a long illness. Mr. Jacob was 60 years old.

T. HAMILTON, former engineer of motive power of the Pennsylvania at Philadelphia, Pa., who retired from that position in 1938, died on December 26, at his home at Chambersburg, Pa. He was 66 years old.

OTTO JABELMANN, vice-president in charge of research and mechanical standards of the Union Pacific at Omaha, Neb.,

Otto Jabelmann

died on January 6 in London, England, while he was on a special mission abroad in connection with lease-lend distribution. Mr. Jabelmann had journeyed to England at the request of W. A. Harriman, lease-lend expediter, who accompanied him. Mr. Jabelmann was born at Cheyenne, Wyo., on July 24, 1890, and entered railway service as a call boy for the Union Pacific on September 22, 1906. He has been continuously in the service of the Union Pacific since that time, with the exception of three years during which he attended the University of Michigan and a period from May to August, 1917, when he was a machinist on the Southern Pacific at San Francisco. He advanced through the mechanical department, serving successively as apprentice, machinist helper; machinist and assistant enginehouse foreman at Cheyenne; general foreman at Laramie, Wyo.; machinist at North Platte, Neb.; enginehouse foreman, district foreman, and superintendent of shops at Cheyenne. On January 1, 1929, he was transferred to Omaha as superintendent of shops and in October, 1933, became general superintendent of motive power and machinery at Omaha. He was appointed assistant to the president in charge of research in November, 1937, and in June, 1939, was elected vice-president in charge of research and mechanical standards.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers, preferably on company letterhead, giving title. State the name and number of the bulletin or catalog desired, when it is mentioned.

TURRET LATHES.—International Machine Tool Corporation, Foster Division, Elkhart, Ind. Sixteen-page illustrated bulletin descriptive of Foster No. 5 Universal ram type turret lathes.

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MILLING MACHINES.—Cincinnati Milling and Grinding Machines, Inc., Cincinnati, Ohio. Publication No. 0-8, M-964-1 descriptive of Plain Automatic Milling Machines with or without rise and fall spindle carrier.

◆

TURRET MILLS.—Rogers Machine Works, Inc., 125 Arthur street, Buffalo, N. Y. Twelve-page illustrated catalog of Rogers "Perfect 36" vertical turret mills for boring, drilling and turning, with condensed specifications for standard and high-speed models.

◆

"RAILROAD CLEANING HANDBOOK."—Magnus Chemical Company, Inc., Dept. REE, Garwood, N. J. Twenty-six pages, illustrated. Four sections—Cleaning Problems of: General Repair Shops (cleaning Diesel engine parts, air pumps, vats, and grinding chilled-steel car wheels); Paint Shop (stripping paint from rolling stock); Terminal Yard (cleaning coach exteriors and interiors, upholstery, etc.); Other Railroad Cleaning Problems (radiator and cooling systems, floor and window cleaning, etc.).

Anderson Dependable

PLUGS AND RECEPTACLES *Trouble free*

WE accentuate the feature of trouble free service when Anderson Plugs and Receptacles are used, for it is especially desirable now. This equipment has proven itself over a score of years under all sorts of conditions with many different railroads. Right now the value of quality apparatus is showing up — showing that it has and does pay to install Anderson material — the kind that calls for the minimum of maintenance.

Air Conditioning
Battery Charging
Marker Lights
Yard Receptacles
Platform Receptacles
Portable Tools
Telephones
Switchboards
Welding
Cable Connectors
Couplers
Watertight Plugs & Receptacles
Turntables
Industrial Trucks

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NEW YORK CHICAGO PHILADELPHIA LONDON

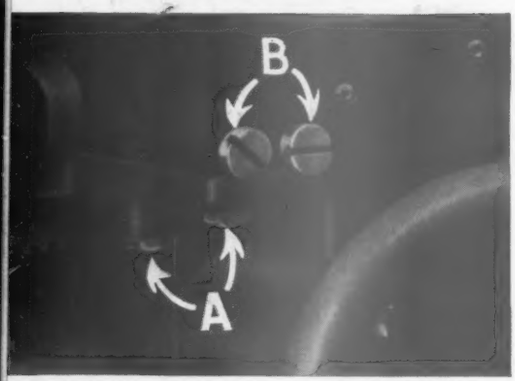
I'm Tellin' You

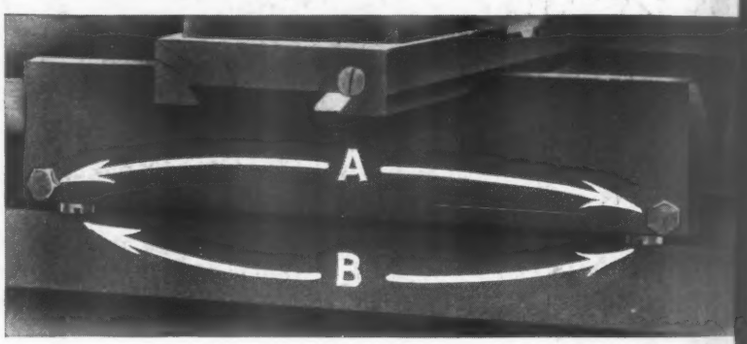
No. 6 in a series of tips on "Keeping 'em Turning"
by Charley Wetterer, 43 years at LeBlond.

"Clean your teeth twice a day and see your dentist twice a year is a pretty good general rule. Lathe care would be a lot simpler if we could set up some kind of slogan like that for adjustment. But the schedule for lathe adjustment varies greatly with the number of work hours per day, the kind of material machined, regular or intermittent cut, condition of tools used, etc.

However, chatter in the work is a pretty fair sign that adjustment may be needed. The most common source of this kind of trouble is slack in the bearings at these two points. Both are easily fixed.

ADJUSTING CARRIAGE GIBS





Each of the two front gibs on the carriage have a bearing on the side of the Veeway and are held in position by the two cap screws (A). Two adjusting set screws (B) hold the carriage gib firm against the side of the ways. To take up slack caused by wear on the bearings, loosen bottom screws (A), then tighten side screws (B) until you feel slight pressure of gib against the way. Now retighten bottom cap screws.

On the long gib in the rear of the carriage which does most of the work, the position of the cap and adjusting screws (B) are on the bottom. However, the procedure in relation to cap and adjusting screws is the same, i. e., loosen (A), tighten (B), then retighten (A).

ADJUSTING SPINDLE

Wear in anti-friction bearings of the spindle is another cause of vibration of the work on old lathes. Here the adjustment procedure itself is simple, but is different for each type of lathe. For information on eliminating end play or longitudinal movement in your particular lathe, write me for easy instructions.

ARMY E NAVY

THE R. K. LeBLOND MACHINE TOOL COMPA
Cincinnati, Ohio
Largest Manufacturer of a Complete Line of La